

# Guidelines for Green Design of Televisions

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**Abstract.** This paper regulates the purposes and basic principles of green design of televisions, and provides the green design requirements and procedures of televisions. This paper will provide the guiding targets for the television manufacturer, standardize the enterprise behavior of televisions, and lead the television product enterprise to implement the product green design, which is of great significance in promoting the transformation and upgrading of television product, enhancing the green manufacturing level and increasing the green product supply.

## 1 Introduction

Television is one of the earliest industries in China's home appliance industry to enter the stage of market-oriented development. After decades of development, television products have entered thousands of households. By 2021, the number of colour television sets owned by 100 households in China will reach 121.8. In terms of annual production, the output of colour television sets in China reached 196.262 million in 2020, with a year-on-year increase of 4.7%; In 2021, the output of colour television sets in China reached 175.128 million. Carrying out green design for televisions, meets the needs of consumption upgrading and increases the supply of green products so that consumers can choose and use green products.

Green design of televisions is also known as “design with environmental awareness”, “eco-design” or “environmental design”, which means the activity of introducing environmental factors to the design and development of products to improve the environmental performance of televisions in their life cycle and optimize the environmental impact of televisions. Researches show that 80% of resources consumption and environmental influence depends on the product design stage, when full consideration will be given to existing technical conditions and raw materials guarantee. Optimizing and solving resources and environmental problems at each stage can realize resource saving to the greatest extent and reduce environmental pollution from the source [1, 2].

## 2 Purposes and basic principles of green design of televisions

The green design of televisions aims at reducing the environmental influence at the design, raw materials selection,

production, packaging, transportation, distribution, utilization, scrapping and subsequent treatment and disposal of products through green design, reducing the pollution from televisions towards the environment, improving the recycling rate of televisions to lessen the adverse impact of televisions on the environment in the whole product life cycle, developing green design methods for modularized, waste-minimized and hazard-free products, and creating ecological, economic and sustainable televisions system.

Basic principles of green design of televisions include: demand orientation, advanced technology, scientific methods, environmentally friendly, economic rationality and compliance with laws.

## 3 Product green design process and key points

### 3.1 Outline

The green design of television products usually includes the following processes: a) Product demand analysis; b) Identification of environmental factors; c) Introducing environmental factors into the process of product ecological design; d) Life cycle analysis and evaluation; e) Ecological design information sharing.

### 3.2 Product Demand Analysis

Designers should carry out product ecological design while meeting product functions, and comprehensively consider factors such as resources, energy and environment, as well as the needs of laws and regulations, technical standards and customer market, so as to meet the goal of product ecological design.

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Product demand analysis includes but is not limited to the following points: a) Product ecological design objectives; b) Product function design; c) Requirements of laws and regulations; d) Technical standards; e) Customer and market needs.

### 3.3 Identification of Environmental Factors

Identifying typical environmental factors and corresponding environmental impacts is an important prerequisite for

product ecological design. Designers can identify environmental factors according to GB/T 28179[3]. The identification and analysis of these environmental factors can provide a basis for ecological design, identify, evaluate and determine important environmental factors as soon as possible, and consider introducing these factors in the process of product design and development, so as to improve the environmental performance of products. Table 1 gives the identification process of environmental factors of television products.

**Table 1.** Identification of environmental factors of television products

Environmental factor	Design considerations	Product life cycle phases involved				
		Raw material acquisition	Manufacturing	Transportation and distribution	Use and maintenance	End of life disposal
Hazardous substances	Compliance and reduction of hazardous substances in raw materials (parts, coatings, etc.)	√	√		√	√
	Compliance and reduction of the use of hazardous substances in packaging materials	√		√		√
	Compliance and reduction of the use of hazardous substances in production accessories	√	√			
	Compliance and reduction of the use of hazardous substances in consumables	√			√	√
Material efficiency	Reduce the types of raw materials	√			√	√
	Reduce the consumption of raw materials	√		√		
	Green process of material processing		√			
	Improve the recycling performance of raw materials	√				√
	Reduce the environmental impact of raw material production stage	√				√
	Reduce the consumption of packaging materials	√		√		√
	Improve the recycling performance of packaging materials	√				√
	Reduce consumption of consumables	√			√	√
	Improve the recycling performance of consumables	√			√	√
Reduce the consumption of production auxiliary materials	√	√				
Battery or power supply	Battery or power supply compliance	√			√	√

Environmental factor	Design considerations	Product life cycle phases involved				
		Raw material acquisition	Manufacturing	Transportation and distribution	Use and maintenance	End of life disposal
	Consider the disassembly of battery or power supply				√	√
	Consider the life of the battery or power supply				√	√
Energy consumption	Improve product energy efficiency				√	
	Reduce energy consumption in product production process		√			
Pollutant emission	Reduce the emission of harmful substances in the use stage of products				√	
	Reduce noise emission during product use				√	
Product longevity	Reasonably extend product longevity (modular design, parts replaceability, software upgrade)				√	
Recycling, utilization and disposal	Consider reuse, recycling and reasonable disposal					√
	Reduce environmental toxicity of final waste					√

### 3.4 Introducing Environmental Factors into the Process of Product Green Design

#### 3.4.1. Function, Performance and Process Design.

The design and development of products shall meet the requirements of relevant functions in SJ/T 11343 [4], including appearance and structure, function and performance, safety, power adaptability, noise, electromagnetic compatibility, environmental conditions and reliability.

On the basis of meeting the functional requirements of products, ecological design ideas and concepts should be incorporated into the design and development process of the whole product life cycle, including conceptual design and structural design before product finalization.

#### 3.4.2. Improve Material Efficiency.

The choice of materials will affect the environment. The method of improving material efficiency can be considered in the process of product ecological design according to GB/T 34144 [5].

When selecting materials, designers should consider the following factors: reduce the types of materials used; Reduce the amount of materials used, so as to reduce the weight of products; Use materials that have little impact on the environment; Use materials that are easy to recycle.

#### 4.4.3. Restrict the Use of Hazardous Substances.

Reducing or eliminating the use of hazardous substances and products should be one of the priorities in product design. Designers need to know the management list of banned hazardous substances and hazardous products in international, regional and product export target countries in time to ensure that the products sold in the target countries meet the requirements of relevant laws, regulations and standards. Designers should minimize the use of substances that require special separation or disposal at the end of product life.

For substances requiring special treatment or disposal, appropriate information shall be provided to product users and recyclers. The use of restricted substances in products should be identified in accordance with SJ/T 11364 [6], and the inevitable use of hazardous substances and reasons should be recorded in the design process. Appropriate design methods should be adopted to reduce the use of harmful substances in high-risk parts such as television product shell, remote controller and external power cord.

#### 3.4.4. Reduce Chemical Emissions.

Appropriate design methods should be adopted to reduce the possibility of chemical emissions with negative envi-

ronmental impact during the use of products, such as volatile organic pollutants.

#### **3.4.5. Reduce Noise Emission.**

Designers should consider techniques to reduce noise emissions. The method of reducing noise emission can be adopted according to GB/T 34959 [7].

#### **3.4.6. Improve Energy Efficiency.**

The design and development of products shall meet the requirements of GB/T 24850 [8] on energy efficiency limit value and energy efficiency grade of flat panel TV. The method in GB/T 34959 should be adopted to improve the energy efficiency of products. In the energy-saving design, the expected use mode of television products should be fully considered, including working mode, energy-saving mode, off mode and no-load mode. Appropriate design methods are adopted to minimize the energy consumption under various modes, such as optimizing the standby mode, which does not provide image or sound, but can be switched to other modes through remote control.

#### **3.4.7. Consumables.**

Consider the design and disposal of consumables based on the principle of reduction, modularization and reuse: the function of reducing or saving the use of consumables; Convenient replacement or maintenance of consumables. The manufacturer can provide users with information about the correct use of consumables and, where appropriate, the end of life processing information of consumables.

#### **3.4.8. Battery.**

If the battery is used in the product, the design of the battery in the product should be considered from the aspects of battery type, control of harmful substances in the battery, battery durability, easy disassembly and recycling, and so on.

#### **3.4.9. Reasonable Extension of Product Life.**

When technically and economically feasible, the service life of the product design shall be reasonably extended and matched with the service life of components, and it is easy to upgrade and repair. The methods to reasonably extend the service life of products include: using common mechanical packaging (such as cover and chassis) or common parts or product types, which are the same parts used by multiple models or the same parts used by the same product for multiple generations, and allowing the reuse of common parts; Use standardized components, which can be easily replaced or repaired; Modular design; Whenever the reuse of modules, components and products is applicable, the reused components (such as for maintenance and spare parts) should be identified.

It is encouraged to optimize the service life of products, and the information of effective options for product upgrading, expansion and maintenance should be available. Examples of design methods for prolonging product life include: modular, compatible and scalable design of television products; If a compatible and extensible interface is set, the operating system can be updated.

#### **3.4.10. Reuse, Recycling and Reasonable Disposal.**

The design of products should be convenient for reuse, recycling and reasonable disposal at the end of product life. The requirements for reuse, recycling, recycling, treatment and disposal of waste products shall be implemented in accordance with GB/T 23685 [9]. Designers need to understand the regulations and standards related to the disassembly and recycling of waste electrical and electronic products to ensure the compliance of product sales in the target countries. The end-of-life disposal of products should be designed according to GB/T 31376 [10].

#### **3.4.11. Packaging.**

The selection and design of packaging materials will have an impact on the environment. When determining materials and designing packaging, designers should consider the following options: reduce the use of packaging materials through reasonable structural design and material selection, so as to reduce the weight and size of packaging when fully protecting products; Use materials that have little impact on the environment; Use recyclable materials; Use renewable/recyclable materials (considering available recycling technologies).

The minimum requirement for designers is to ensure compliance with international, regional and national regulations related to the following contents: restrictions on hazardous substances and hazardous products; Regeneration capacity, such as reuse or recycling; The appropriate identification (material content) of packaging materials shall be in accordance with the marking requirements of GB/T 18455 [11].

### **3.5 Life Cycle Analysis, Evaluation and Continuous Improvement**

In order to confirm and improve the level of product ecological design, the methods of life cycle analysis and evaluation can be used to establish and implement the procedures of ecological design review and continuous improvement. The process of product life cycle analysis, evaluation and continuous improvement of product ecological design includes the following steps:

a) Product Description: determine the product boundary and goal of the design, including: model, specification, function, energy efficiency grade, life expectancy, etc.

b) Product demand analysis: requirements of interested parties (laws and regulations, standards, customers, etc.) in terms of function, resources, energy, environment, human health, and so on;

c) Product life cycle diagnosis: analyze and diagnose the whole life cycle of the benchmark product, put forward the potential and key points for environmental performance improvement, and put forward the improvement demand;

d) Preliminary evaluation of product ecological design scheme: conduct preliminary evaluation on the improved scheme and confirm the product ecological design scheme;

e) Product life cycle assessment: complete the whole life cycle assessment report of benchmark products and target products according to Appendix A of GB/T 24040 [12], GB/T 24044 [13] and GB/T 34664 [14];

f) Evaluation of product ecological design scheme: analyze and compare the environmental performance of the whole life cycle evaluation report of the target product and the benchmark product, and give the conclusion of the environmental performance of the target product;

g) Scheme selection: select the ecological design scheme of target products and benchmark products;

h) Scheme review: review the best scheme;

i) Scheme output: confirm whether the design scheme of the target product meets the product requirements. If so, carry out design implementation, effect evaluation and information sharing; If the expected product demand is not met, continue to put forward improvement suggestions, and re-evaluate the scheme after adjustment until the expected product demand is met.

## 4 Conclusions

The green design of televisions provides guidance for enterprise designers in green design when carrying out product design and development, from the basic principles of product green design, product demand analysis, environmental factor identification, design and development process, life cycle analysis and improvement, and information sharing, etc. Identify environmental factors at all stages of the life cycle, such as waste recycling, propose product ecological design requirements in terms of resources, energy and environment, improve the renewable utilization rate of products, reduce adverse environmental impacts in the entire life cycle of products, and develop more ecological, economic and sustainable product systems.

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3. GB/T 28179 Environmentally conscious design for electrical and electronic product - Identification of environmental aspects
4. SJ/T 11343 General specification for digital television LCD displays
5. GB/T 34144 Guidance on material efficiency considerations in environmentally conscious design of electrical and electronic products
6. SJ/T 11364 Marking for control of pollution caused by electronic information products
7. GB/T 34959 Audio/Video, information and communication technology equipment—Environmentally conscious design
8. GB/T 24850 Minimum allowable values of energy efficiency and energy efficiency grades for flat panel televisions and set-top boxes
9. GB/T 23685 General technical specifications of recovering for waste electrical and electronic equipment
10. GB/T 31376 Requirements of disassembly and treatment for waste electrical and electronic product—LCD televisions and display devices
11. GB/T 18455 Package recycling marking
12. GB/T 24040 Environmental management - Life cycle assessment - Principles and frameworks
13. GB/T 24044 Environmental management - Life cycle assessment - Requirements and guidelines
14. GB/T 34664 General assessment principles for electrical and electronic eco-design products