WE –EEN
Wizard of the Environment: the Enterprise Europe Network

Eurosportello del Veneto
Via delle Industrie 19/C Venezia

Electronics industry and the environment

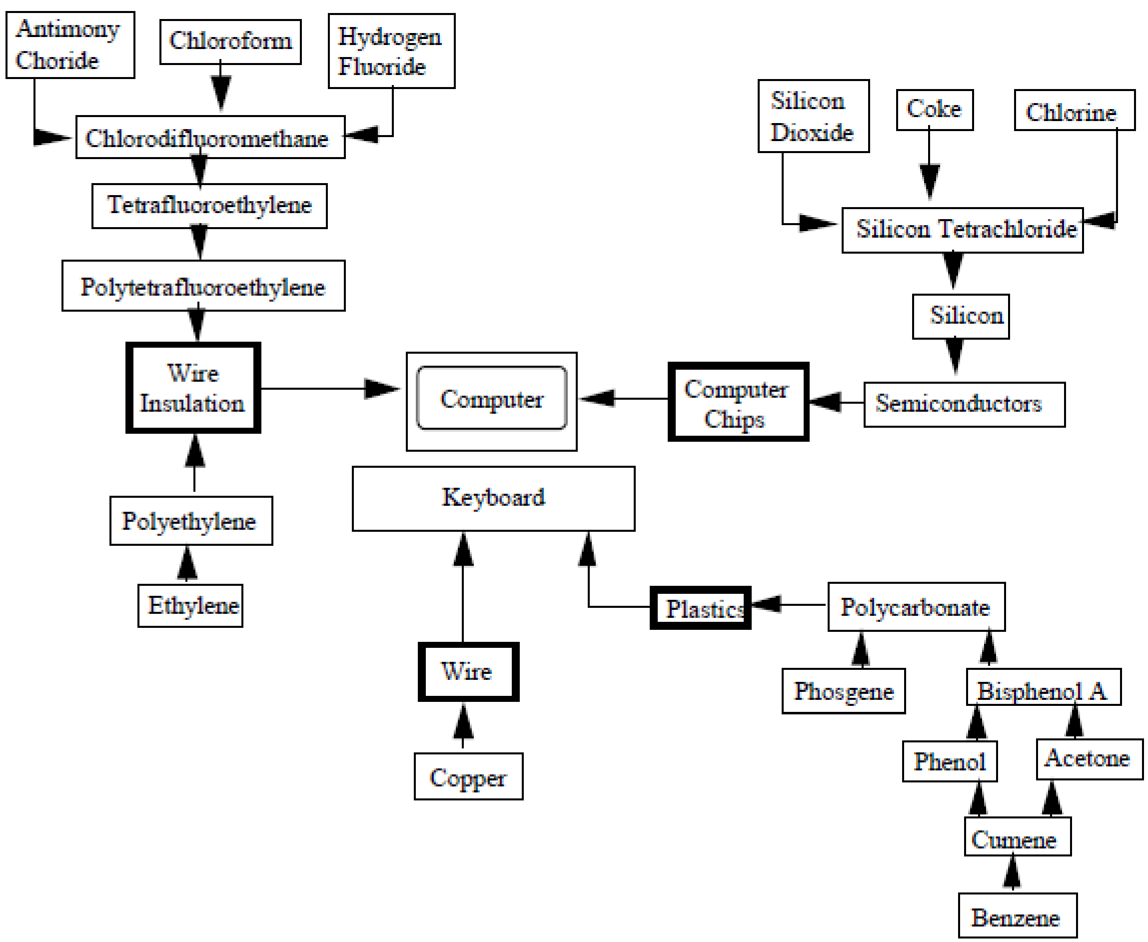
Concerns about the environmental impact of electronic products and industry have led to a variety of efforts.

An example of this is the proliferation of “eco-logos”, worldwide. The fragmentation, confusion and duplication of efforts signifi cantly raises costs for all. Manufacturers of Information and Communication Technology (ICT) and Consumer Electronics (CE) products are addressing this problem proactively with standardization through Ecma International.

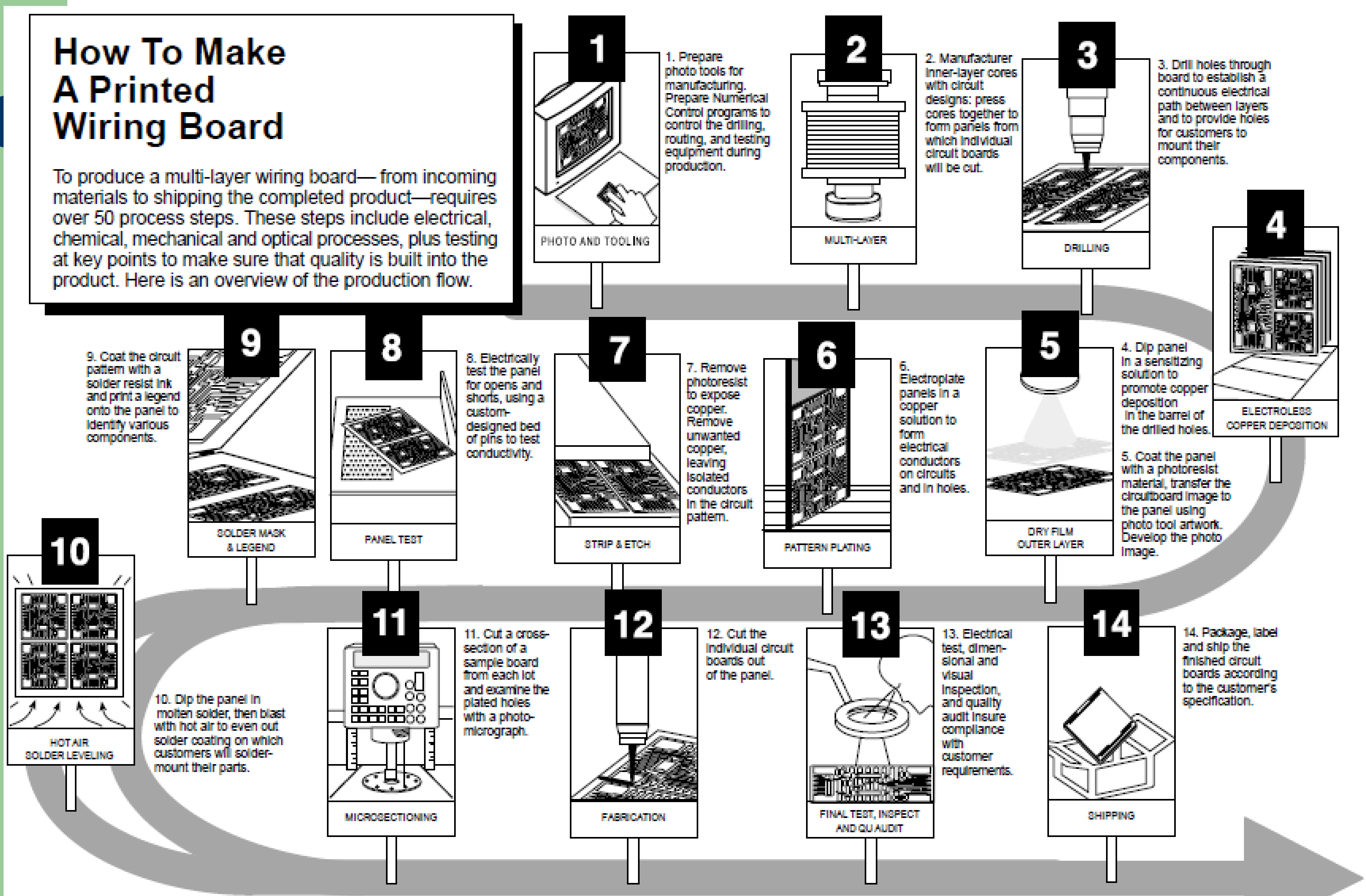
Electronics industry and the environment

Conflicting and overlapping eco-label requirements, with a fragmented world-wide legislative environment, increase complexity and costs, and provide little information on product enviromental attributes.

Chemical-use mapping



Production of PWB



Significant Materials used in Electronic products

Glass: The electronics industry generates glass cullet for product applications such as color television picture tubes, color computer monitors, and monochromatic monitors. The old CRT displays of television sets and computer monitors contained heavy metals, making the sets difficult to recycle. Glass constitutes about 50%, by weight, of the material in TV sets and represents a major recycling potential. Modern video displays contain at least six different glass elements, each with unique compositions and engineering requirements. In general, mixed glass is unsuitable for recycling.

Significant Materials used in Electronic products

Plastics: One of the problems with plastics recycling and recovery is the difficulty in getting high-quality material. While thermoplastic materials are recyclable, mixtures are unacceptable (15 to 20 types of plastics are used in producing a television set), so there is a need to reduce the variety of plastics used in specific products to a single material. Current plastics-marking practices offer little help, as the type of additives, fillers, or flame retardant materials is not supplied

Green supply chain

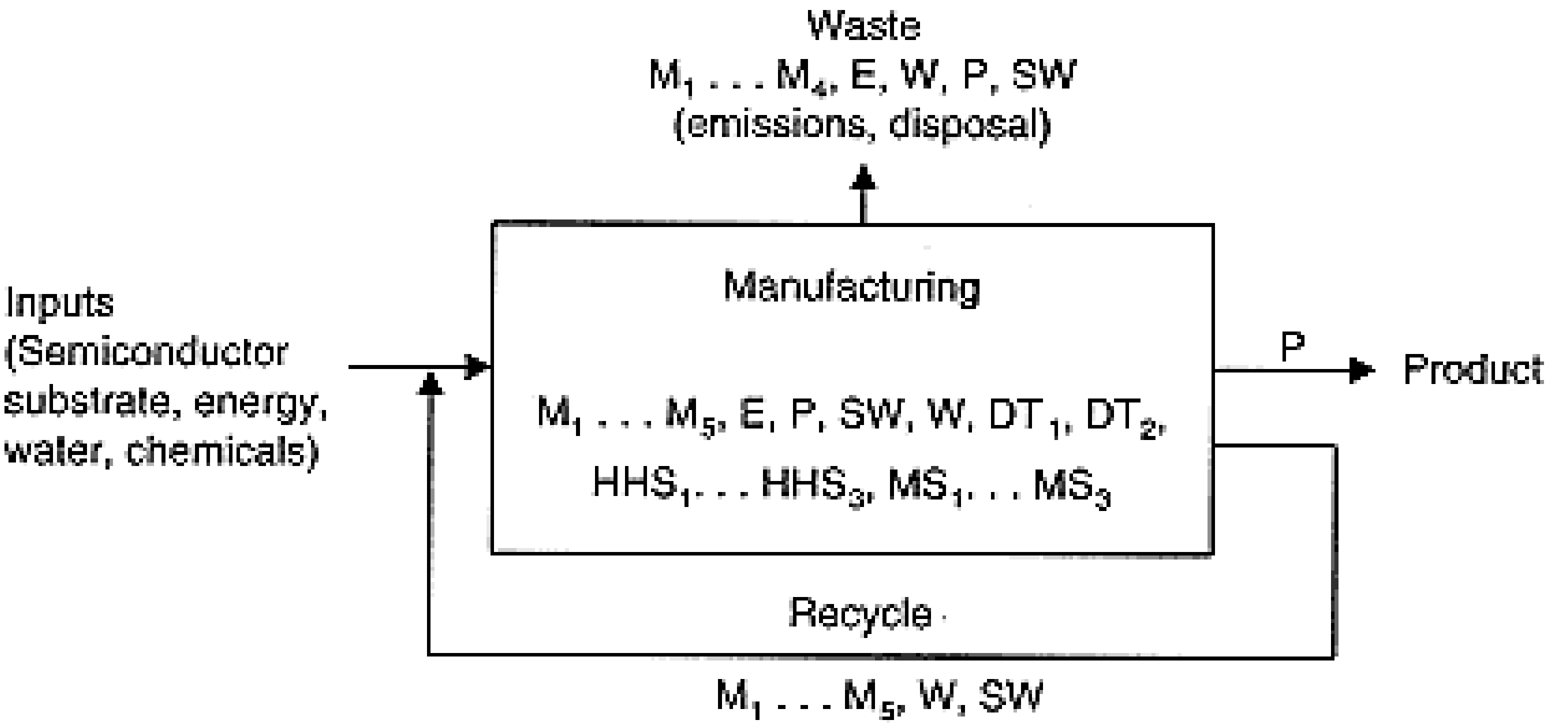
While large strides in product recycling, energy efficiency and green manufacturing processes also command interest, many manufacturers find that they must educate their suppliers about regulatory issues and help suppliers deliver materials, components and subassemblies that meet their design goals.

Unified materials format

Other challenges on the supply chain front include the development of a unified format for materials reporting that will harmonize the divergent requirements of the American Electronics Industry Association, the European Industry Association and Japanese standards.

Another major topic is product take-back practices and reverse supply chain logistics.

Metrics used in semiconductor manufacturing



Metrics used in semiconductor manufacturing

- M1 = TRI chemicals (included in the Toxics Release Inventory program)
- MS1 = Environmental management systems
- M2 = Ozone-depleting substances
- M3 = 33/50 chemicals (EPA waste reduction program)
- MS2 = Regulatory inspections
- M4 = Hazardous waste
- MS3 = Compliance issues
- M5 = SARA chemicals (Emergency Planning and Community Right-to-Know Act)
- HHS1 = Accidents/injuries per 100 employees
- E = Energy use (electricity, natural gas, and fuel)
- HHS2 = OSHA recordable injuries and illnesses
- W = Water use

Metrics used in semiconductor manufacturing

P = Packaging materials

HHS3 = Lost and restricted day casesb

SW = Nonhazardous solid waste

DT1 = Environmental cost accounting

DT2 = Design for environment (e.g., number of environmentally designed products)

Environmental Challenges in the Semiconductor Industry

Challenges	Summary of Issues	Possible Metrics
New chemical qualification	Need to conduct thorough new chemical reviews and ensure that new chemical processes can be utilized in manufacturing without jeopardizing human health or the environment or delaying process implementation.	Number of new chemical reviews conducted
Reduce PFC emissions	These gases are used in plasma processing. There are no known alternatives. International regulatory scrutiny is growing.	PFC emissions
Reduce energy and water use	Availability of energy and water may limit location and size of wafer fabrication facilities in certain geographic regions.	Energy and water use, alternative reuse opportunities

Environmental Challenges in the Semiconductor Industry

Challenges	Summary of Issues	Possible Metrics
Integrated ESH impact analysis capability	There is no integrated way to evaluate and quantify the impact of process, chemicals, and process tools.	EHS cost per unit of production
Eliminate PFC emissions	There are no known alternatives and international regulatory pressure.	PFC emissions
Know detailed chemical characteristics before use	Need to document toxicity and safety characteristics because of international regulatory pressure.	Number of risk assessments conducted on new chemicals

Environmental Challenges in the Semiconductor Industry

Challenges	Summary of Issues	Possible Metrics
Lower use of feed water by a factor of 10 and halve cost of water purification	Reducing use and cost of water will improve productivity curve and increase flexibility of factory siting.	Water use, alternative reuse opportunities, cost to provide purer water
Halve energy use per unit of silicon	Desire to reduce global-warming impact of energy use. Energy availability in market area.	Energy use
Integrated ESH impact analysis capability for new designs.	Lack of an integrated way to make ESH a design parameter in development procedures for new tools and processes	Partnering with manufacturing tool suppliers to develop metrics for cleaner tools

Example: Pollution Prevention Efforts Reduce Emissions

Organic solvents are frequently used to remove contaminants from wafer surfaces in semiconductor manufacturing. Typical cleaning processes involve the use of industry standard equipment that specifies parts placement and dictates how solvents are to be applied.

Through innovative parts placements and modification of the solvent application technique, engineers at IBM Burlington (Vermont) were able to substantially increase the number of parts processed per batch and improve cleaning efficiency. The new process reduced the site's solvent use by 1,860 metric tons in 2006 and saved over $5 million in chemical and production costs.

Example: Pollution Prevention Efforts Reduce Emissions

Similarly, through the development and implementation of no-clean fluxes in three processes, IBM's Bromont (Canada) facility has achieved a 70 percent reduction in its perchloroethylene (perc) emissions since 2003.

SOURCE: International Business Machines (2008).

Reporting of Environmental Performance Metrics

Indicators used by Hewlett Packard (http://www.hp.com/abouthp/envrnmnt/)

Hazardous waste generation and disposal (millions of pounds)

Nonhazardous solid waste recycling and disposal (millions of pounds)

ODSs (ozone-depleting substances; pounds)

TRI Chemicals (millions of pounds)

33/50 Chemicals (millions of pounds)

Global warming gases (PFC emissions)

Product/shipping packaging

Energy consumption and product use

Semiconductor Industry. PRODUCTS

Italian semiconductor industry

PRODUCTS

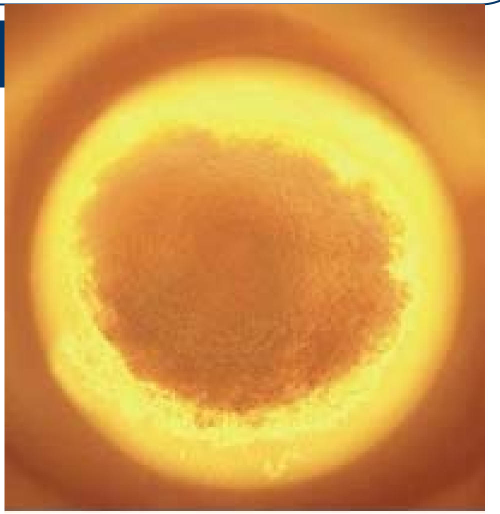
CZ monocrystal: 100mm, 125mm, 150mm, 200mm wafers, Arsenic, Red Phosphorus and Antimony; polysilicon: chunk; Trichlorosilane and Hydrochloric acid

BACKGROUND

Silicon research began at the plant in 1961, and a pilot line, poly through polished slice, started in 1968. In 1976, industrial production began for poly and single crystal.

Semiconductor Industry. PROCESS

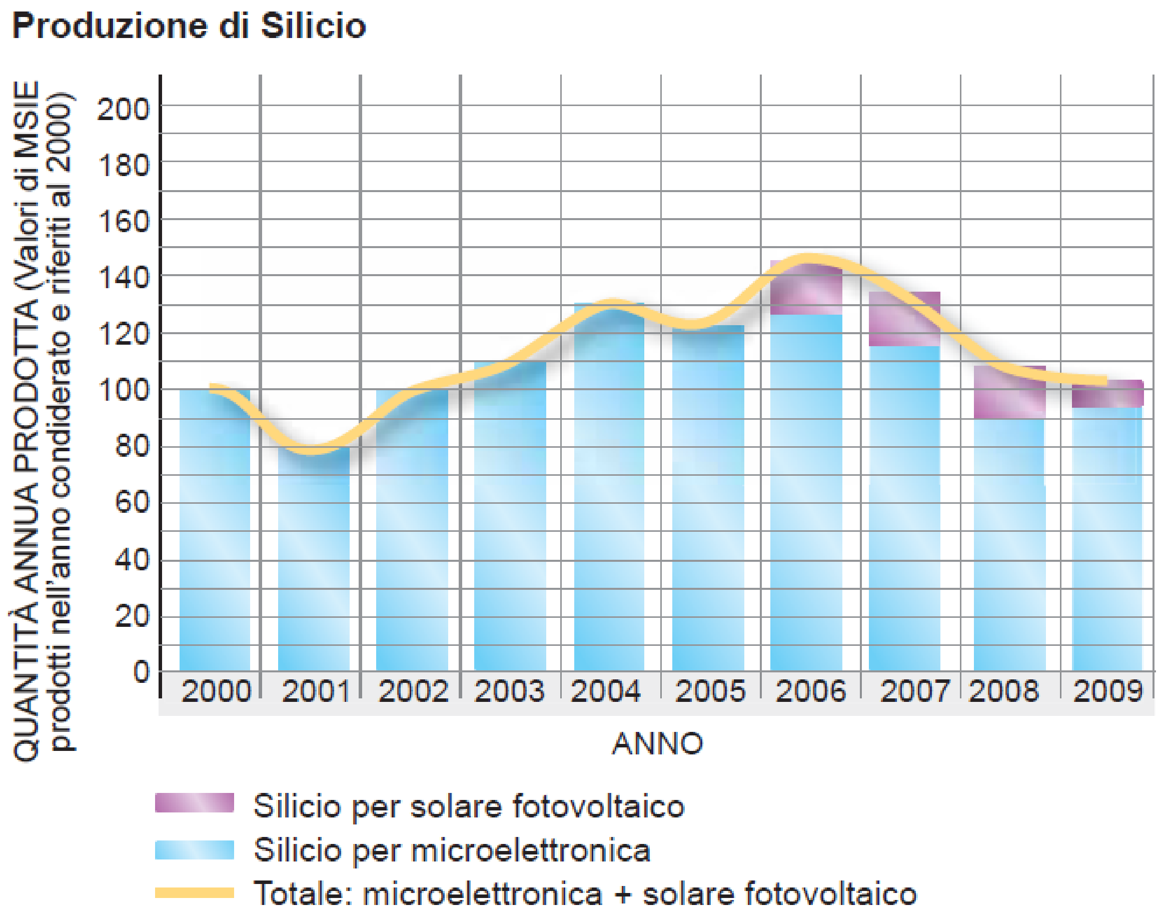
The first, and most critical step in the manufacturing of silicon wafers, is <u>the "growth" of single crystal silicon</u>. To begin, the raw material "polysilicon" is carefully stacked by hand inside a quartz crucible, which in turn, rests inside the furnace tank of a Crystal Puller. A small amount of "dopant" (electrically active elements) such as arsenic, boron, phosphorous or antimony is added to the polysilicon.



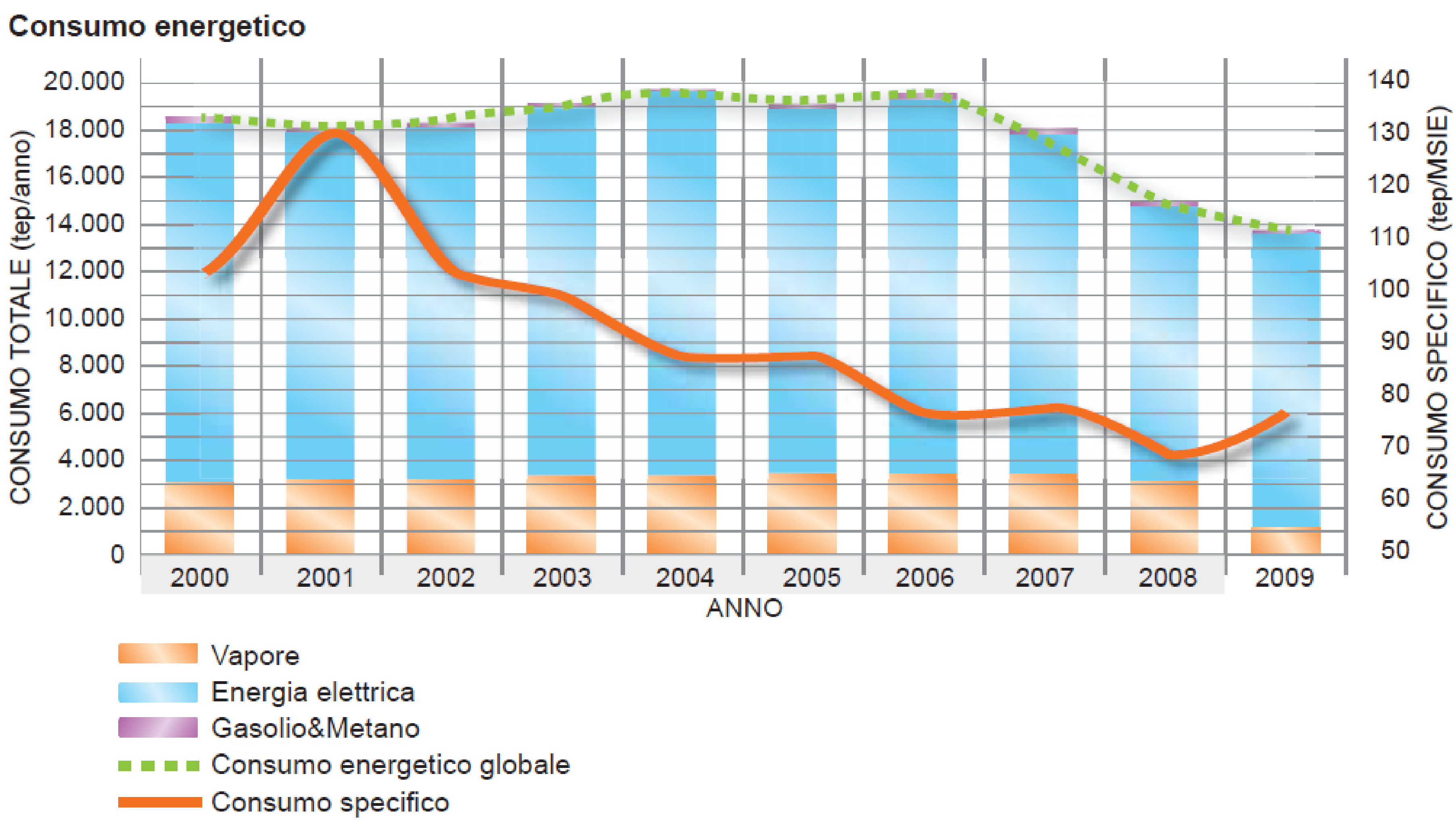
Granular polysilicon in melt phase

Chunk polysilicon in melt phase

Semiconductor Industry. Environmental data



Semiconductor Industry. Environmental data



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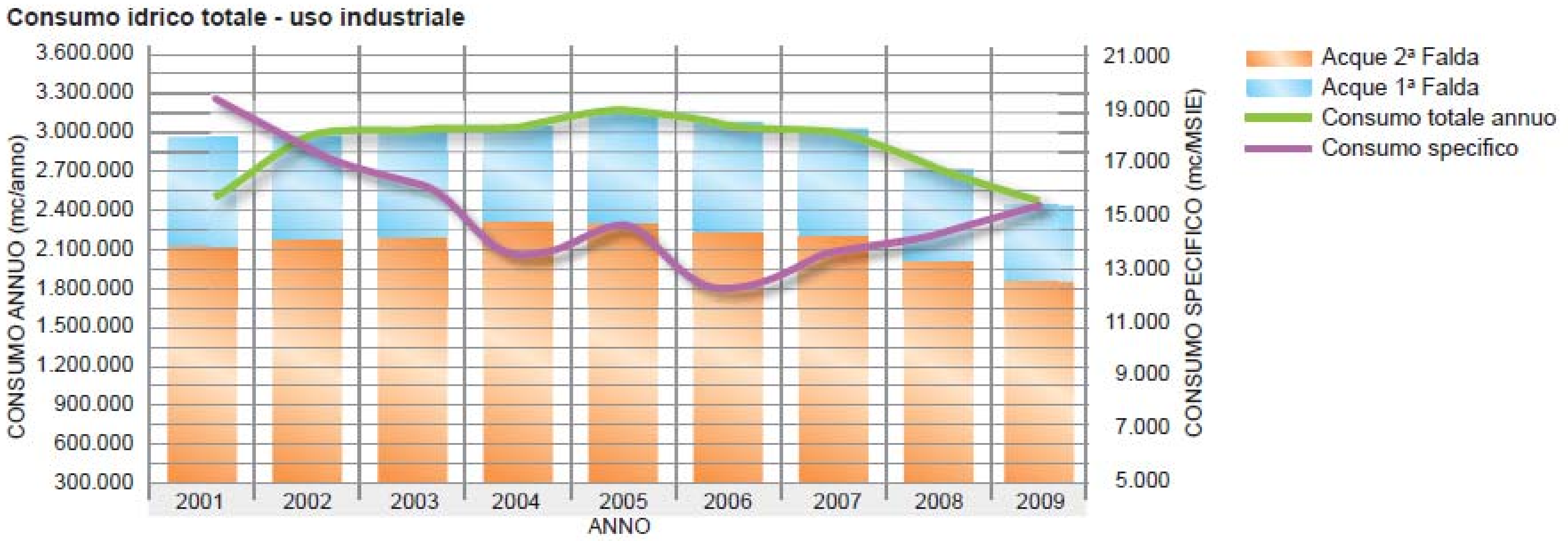

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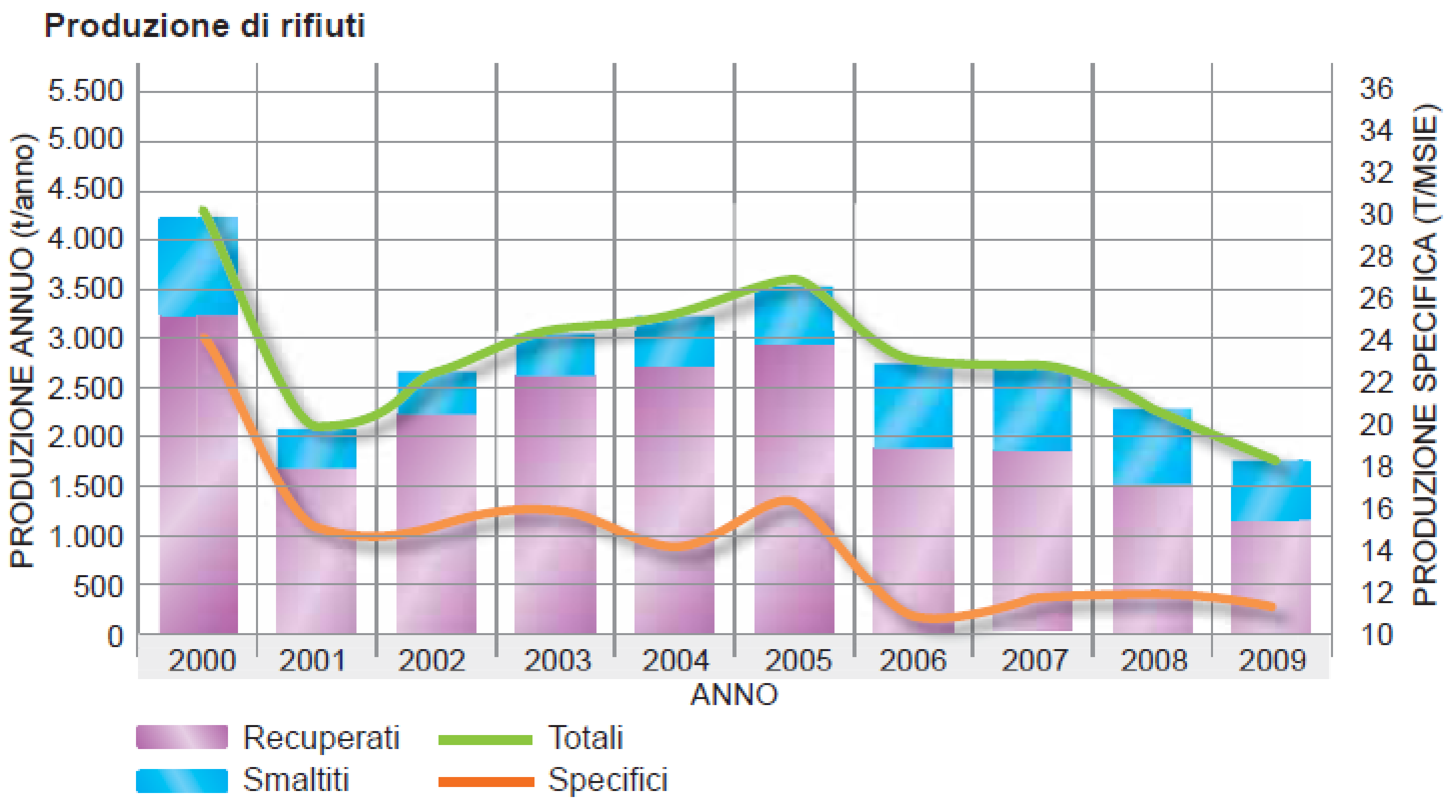

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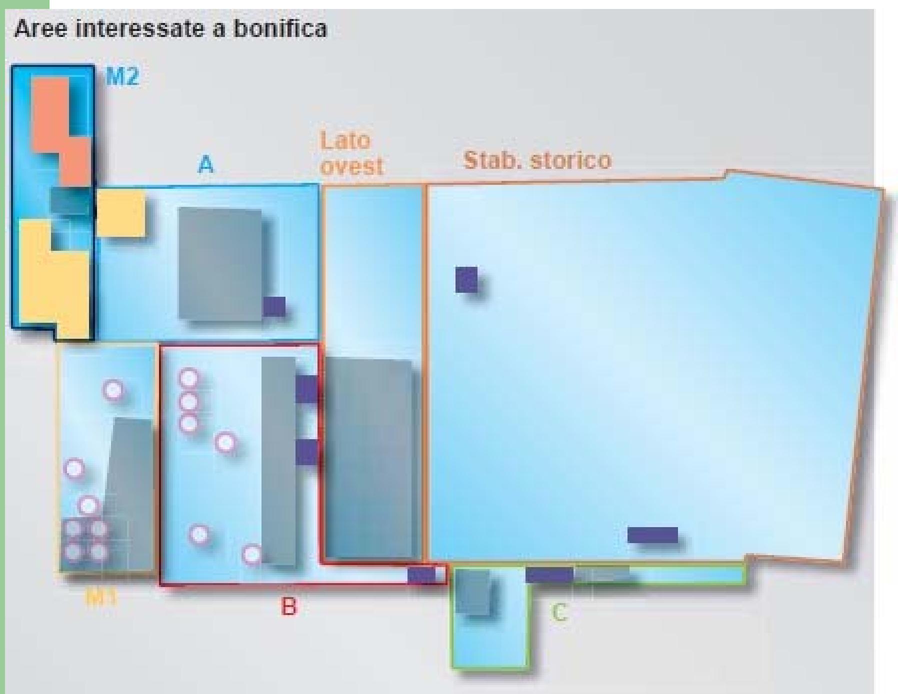


Leggenda

- Aree bonificate nel 1997
- Aree bonificate nel 2004
- Aree bonificate nel 2006
- Aree impermeabilizzate nel 2006
- Aree impermeabilizzate nel 2008

What is WEEE?

Waste Electrical and Electronic Equipment

Definition of "Waste" in Article 1(a) of Directive 75/442/EEC

"any substance or object which the holder disposes of or is required to dispose of pursuant to the provisions of national law in force "

<u>Includes all components,sub-assemblies and consumables which are part of the product at the time of its disposal.</u>

WEEE in Europe

- In 2001 there were ~10,000,000 tonnes of electrical equipment waste in the EU, increasing by 3-5% pa
- Much goes to landfill
- Land filled electronics contains potentially hazardous substances which can leach out into water courses
- Land filling is a waste of valuable resources
- Uncontrolled recycling is a potential health hazard

Where does WEEE fit?

- WEEE (and RoHS) directives address product “end of life” environmental impacts and issues
- The WEEE directive mandates measures for infrastructure, processes and products and seeks to radically change industrial and consumer practice
- The proposed EPR approach will address environmental impacts across the whole product life cycle.

Producer Responsibility

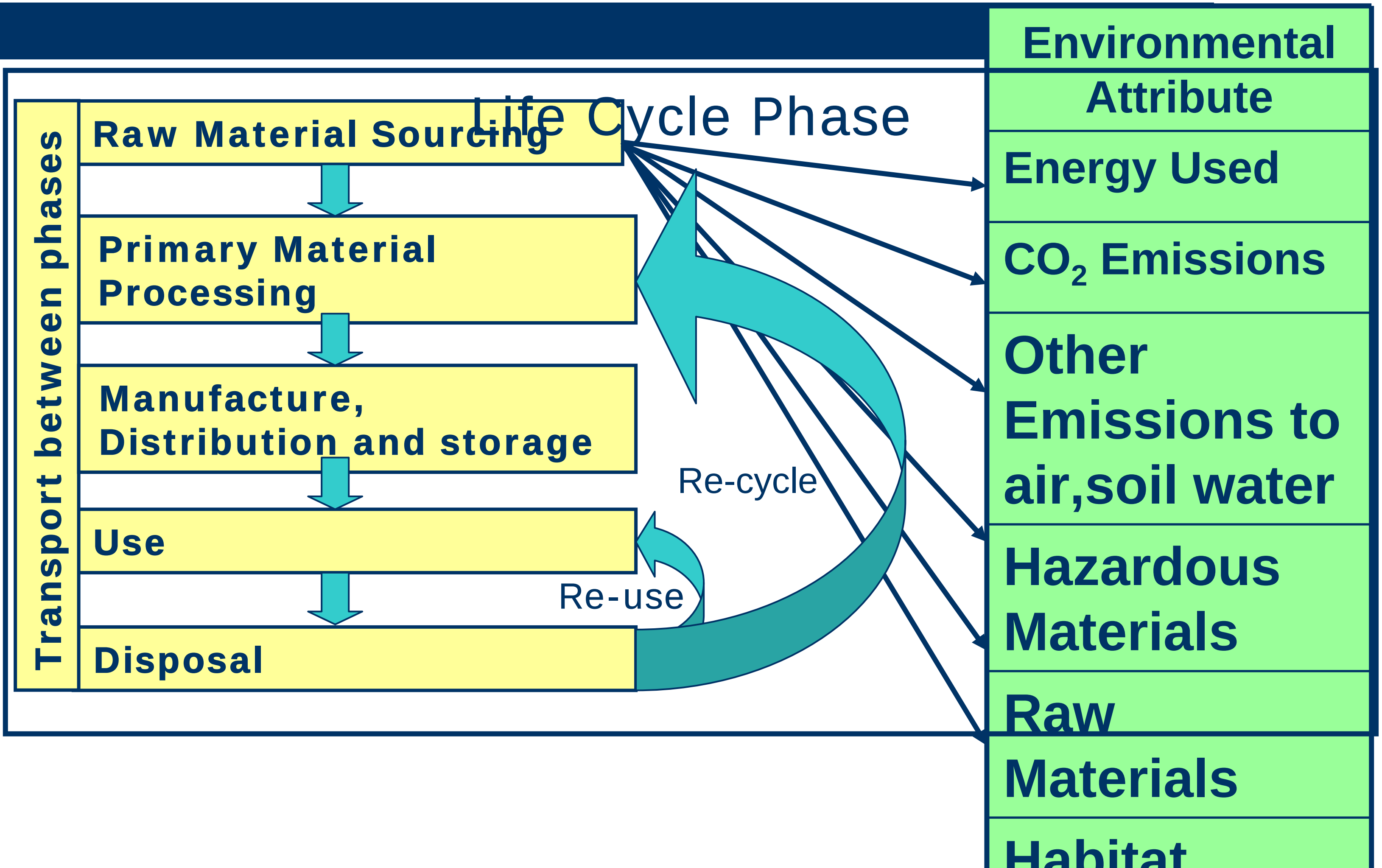
<u>Under"Polluter pays" principle, Producer of products is considered "polluter"</u>

Legal and financial obligations to be applied in legislation.

In applying Producer Responsibility to WEEE, the European Commission have assumed that:

"This financial or physical responsibility creates an economic incentive for producers to adapt the design of their products to the prerequisites of sound waste management."

Life Cycle Approach



What is the WEEE Directive trying to achieve?

Through the better treatment and handling of waste and the promotion of re-use, recycling and other forms of recovery to:

- Reduce risk to health and environment
- Conserve raw materials
- Conserve energy resources
- Reduce contributors to air pollution, including greenhouse gases

WEEE - Main Provisions

- Product Design
- Encourage Eco-design and design for reuse
- Separate Collection
- WEEE to be separately collected funded by producers (4kg/person from households by 31 Dec 2006)
- Treatment
- WEEE to have fluids and certain components removed prior to recovery
- Use Best Available techniques
- Recovery and Recycling
- Producers to finance recycling and energy recovery
- Targets to be mandatory
- Producers to supply information to users, treatment facilities and authorities

Article 2
Categories in Annex 1A

1 - Large household appliances

2 - small household appliances

3 - IT and Telecom equipment

4 - Consumer electronics

5 - Lighting equipment

6 - Electrical tools (ex. large scale stationary industrial tools)

7 - Toys

8 - Medical equipment

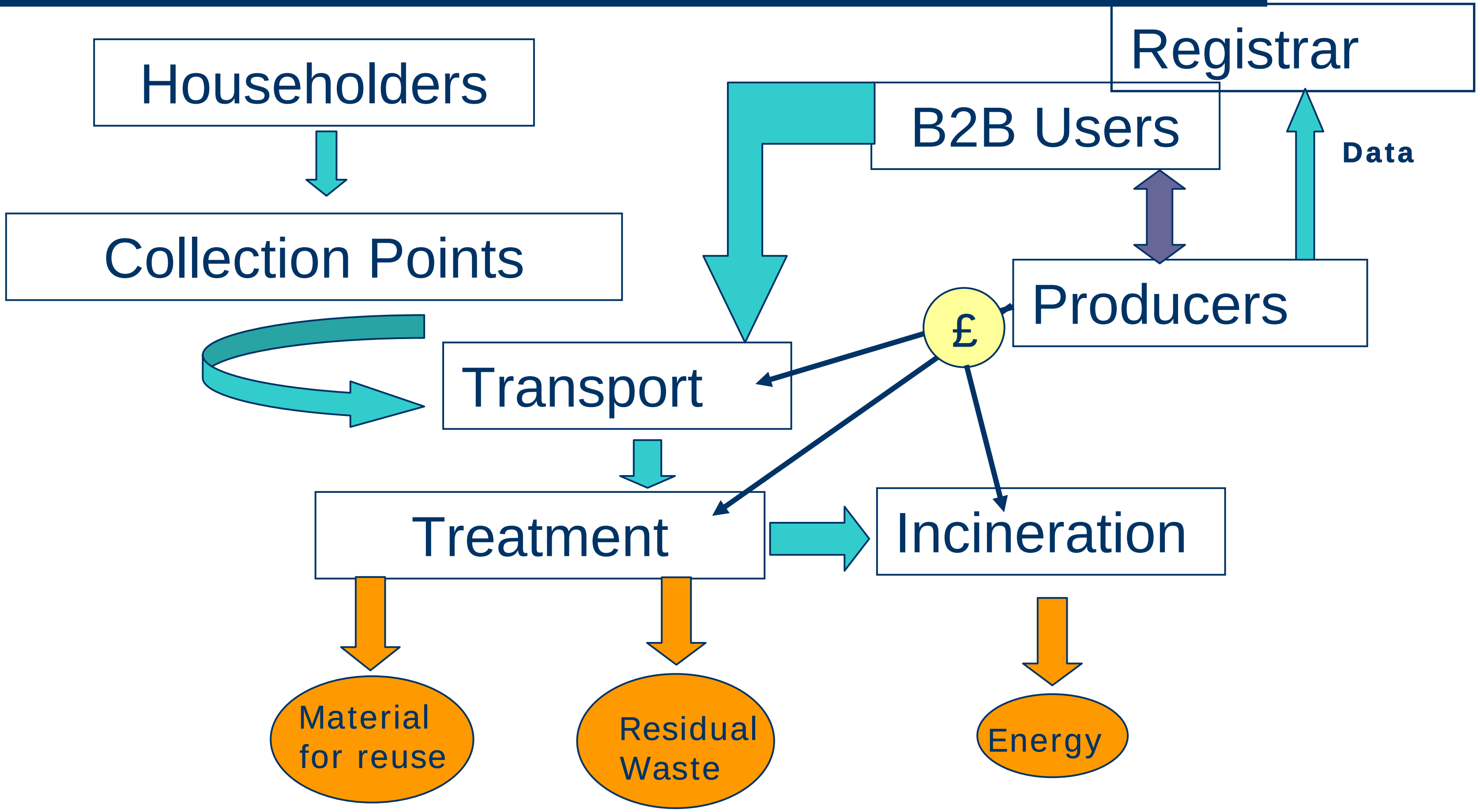
9 - Monitoring and control equipment

10 - Automatic dispensers

Article 7 – Recovery and Recycling Targets

Category	Recovery Rate %	Recycling rate %
1 Large Household Appliances	80	75
2 Small Household Appliances	70	50
3 IT and Telecom Equipment	75	65
4 Consumer Electronics	75	65
5 Lighting Equipment	70	50
6 Electrical Tools	70	50
7 Toys	70	50
8 Medical Equipment	-	-
9 Monitoring and Control Equipment	70	50
10 Automatic Dispensing Machines	80	75
Gas Discharge lamps (Category 5)	-	85

How the WEEE Directive will work



European Union directive 2002/95/EC

EU directive 2002/95/EC “on the Restriction of the use of certain Hazardous Substances in electrical and electronic equipment” or RoHS was implemented in July 2006.

Applies to electrical and electronic equipment designed for use with a voltage rating not exceeding 1,000 volts for alternating current and 1,500 volts for direct current.

The requirements of this directive are applicable to the member states of the European Union.

RoHS, Lead-Free, and Equipment Reliability Reports from the Field

RoHS Directive

Restricts the use of hazardous substances in electrical and electronic equipment.

- Lead (Pb)
- Mercury (Hg)
- Hexavalent chromium (Cr(VI))
- Cadmium (Cd)
- Polybrominated biphenyls (PBB)
- Polybrominated diphenyl ethers (PBDE).

Contributes to the protection of human health.

Environmentally sound recovery and disposal of waste electrical and electronic equipment.

RoHS Directive

All applicable products in the EU market must now pass RoHS compliance.

RoHS impacts the entire electronics industry and compliance violations are costly.

Product quarantine, transport, rework, scrap, lost sales and man-hours, legal action, etc.

Non-compliance reflects poorly on brand and image and undercuts ongoing environmental and “due diligence” activities.

Lead free products

An aim shared by almost all RoHS legislation is the elimination of lead in electronic products.

The main issue for the electronics industry became the use of lead in the manufacture of components and circuit board assemblies.

PBs have conducting layers on their surface typically made of thin copper foil.

Unprotected copper will oxidize and deteriorate.

Traditionally, any exposed copper was plated with lead(-based) solder by the hot air solder leveling (HASL) process.

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International Business Machine. 1998. Environment: Pollution Prevention. Available at http://www.ibm.com/ibm/environment/annual97/prevent.html. [August 10, 1998].

The Microelectronics and Computer Technology Corporation (MCC): Electronics Industry Environmental Roadmap

Semiconductor Industry Association (SIA). 2007. The National Technology Roadmap for Semiconductors.