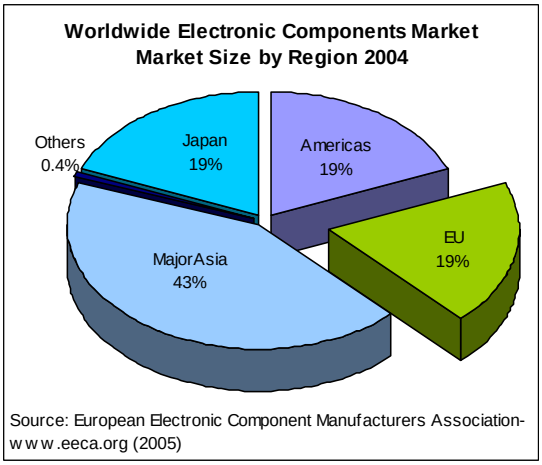
EXPORT Case Information

# Lead-Free Electronic Industry

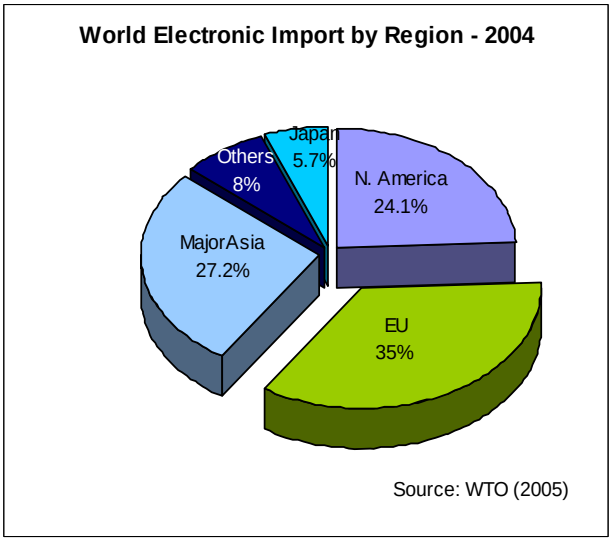
## What?

### *Industry Profile*

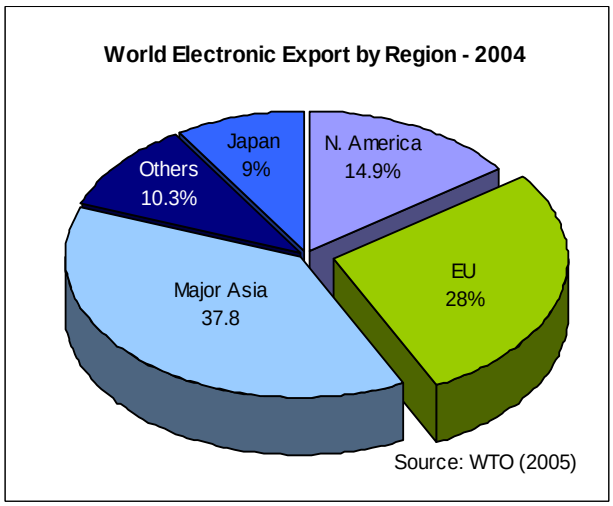
The electronics industry is a fast growing, highly varied, high innovation industry with an extensive international supply chain. Spending on research and development (R&D) in 2003 was equal to 4-7% of annual sales. Exports account for over 70 % of electronics production in the USA. The value of US electronics imports is 1.5 times the value of US electronics exports, with The US acting as both supplier of components and producer of consumer products. Attention to international regulatory frameworks and market preferences is thus critical to state and national industry competitiveness.




Source: European Electronic Component Manufacturers Association- www.eeca.org (2005)




Source: WTO (2005)




Source: WTO (2005)

| ELECTRONICS 2004 | USA | MA |
|---|---|---|
| # of Establishments | 19,827 | 925 |
| Industry Employment | 1,315,291 | 74,119 |
| % Total Employment | 1% | 2% |
| % of Total Wages | 2% | 4% |
| % exports / % imports | Imports / Exports = 1.5 | 78% Export |
| Location Quotient | | 2.32 |
| % of Gross State Product | | 3% |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# WHY?

## Needs and Drivers

Lead is a neurotoxin, possible human carcinogen, probable cause of birth defects and is extensively regulated. Dissipative uses for lead were significantly reduced with the mandatory elimination of lead in gasoline (95 % reduction in air emissions) and near elimination of lead in many other products. Lead-acid batteries accounted for 50% of the total lead usage in 1973 which grew to 84% in 1993 and 2003[i]. Lead and other hazardous materials are still used in the production of electronics and are part of the final product. Electronic equipment is the fastest growing waste product in the EU and US, with almost 90% of E-waste buried or burned[ii].

The EU's Waste Electrical and Electronics Equipment (WEEE) and Restriction of Hazardous Substances (RoHS) directives were put into law in 2002 and come into effect on July 1, 2006, after which certain lead containing electronics products cannot be sold in the EU and manufacturers are responsible for 'takeback' and recycling of 50-80% of their products.

China is adopting EU-like policies on the EU time line to enforce readiness for the EU market[iii]. Other than RCRA regulating hazardous waste transport, the US does not have national regulatory policies on electronics recycling or hazardous material restrictions. However various restrictions and requirements have been adopted by 29 US states. California will prohibit "electronic devices from being sold or offered in California if the products are banned in the EU." [iv]

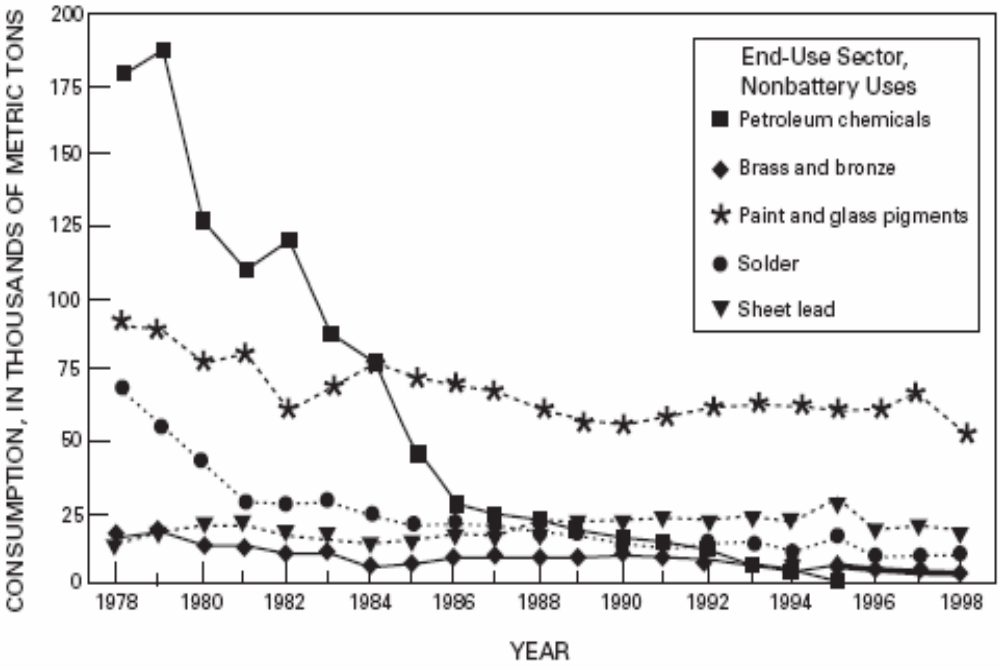



Figure 3. U.S. lead consumption by end-use sector, nonbattery uses from 1978 through 1998.

**Lead used in ammunition is 3% of the total and is not shown.**

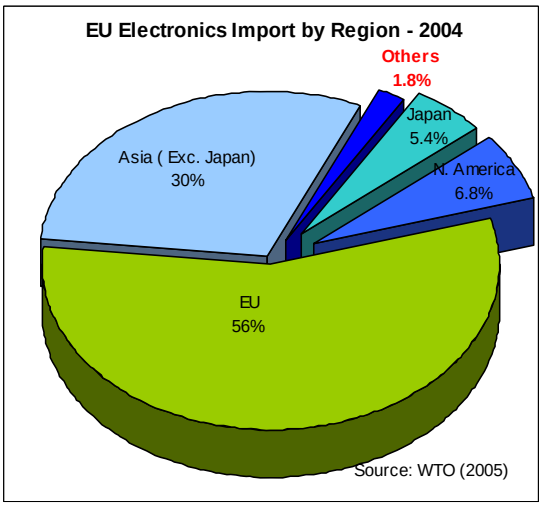
From U.S. GEOLOGICAL SURVEY CIRCULAR 1196-F (1998)

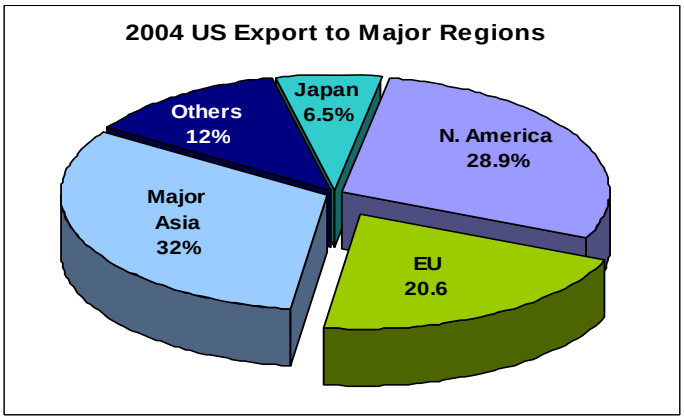
| Policy | Description | Who |
|---|---|---|
| Hazardous material bans, restrictions | Restricts or bans hazardous materials from products | **EU(RoHS),** Taiwan, China (RoHS), USStates |
| Import/Export bans, restrictions | Restricts transport of specified substances | International (Basel Ban), China |
| Extended producer responsibility | Holds producer responsible for EoL materials to encourage consideration for EoL in design | **EU(WEEE),** South Korea, Brazil |
| Recovery, collection targets | Mandates targets for collection and/or recycling of material | **EU(WEEE),** Japan, Taiwan, China |
| Landfill Bans | Bans landfilling of toxic-containing products such as CRTs, mercury switches, etc. | MA, CA, others |

# HOW?

## Technology History and Challenges

Work over the last several years to develop lead-free solder alloys has identified numerous technical challenges[v]. Because no 'drop-in' lead-solder replacement has been found, lead-free requires a change in design of whole products. Industry has been actively working on developing alternatives, with many industry consortiums[vi] sharing R and D resources. In 1997 one of the largest consortiums conducted a study of 80 lead-free solder alternatives, recommending 3 alloys for further study[vii]. However the rapid time frame of EU legislation, combined with technical difficulties, concerns that new solders will become future regulatory targets, and difficulty agreeing on either a lead-free solder[viii] or a standard definition of 'lead free', have made for a difficult transition with many companies scrambling to meet EU guidelines.

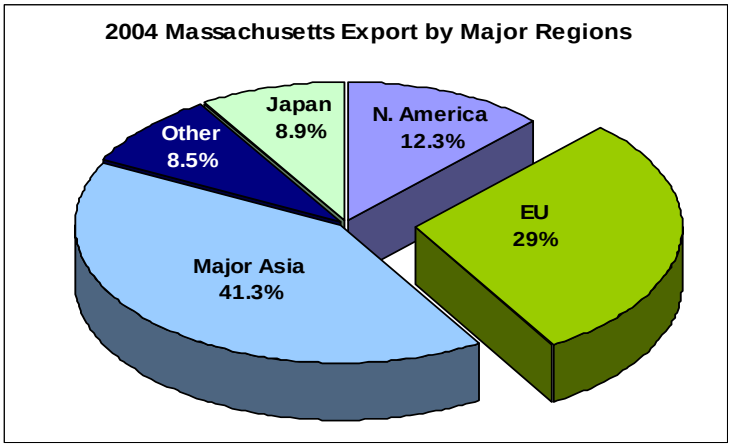



## Going Forward

- **Higher cost and lower profits:** Technology Forecasters Inc. (TFI) polled hundreds of electronics companies, and estimates that RoHS compliance will cost Original Equipment Manufacturers (OEMs) about 2.5 to 3% of their cost of goods sold (COGS). Intel estimates that approximately 90% of all electronic components contain some amount of lead.
- **Retail price increases:** The IPC estimates that lead-free technology will increase product market prices up to 10%. Innovative companies that create lower cost technology can take advantage of higher market prices to maximize profit.

- **Job losses or gains:** Significant increases in cost, outsourcing to compliant facilities, or loss of EU market share due to non-compliance may cause domestic job losses in the industry. Innovative suppliers and OEMs who meet EU regulations with lower-cost technology may gain market share and increase jobs.
- **Market share:** and revenue gains to early-compliance firms and losses for non-RoHS compliant firms that are part of supply chains that serve the EU market.



## STRATEGIES

### ❖ Technology Sharing:

- Speedline Technologies[8], in MA, has been sharing its technologies and experiences to eliminate lead in their products. Speedline is currently providing webinars on meeting the challenges of lead-free production.
- New England Lead-Free Electronics Consortium is a group of industry, academia, and government working together to define acceptable lead-free alternatives for specific electronic needs.

**Alternatives:**

- Convert to RoHS for existing BOM. (RoHS compliant parts not always available)
- Develop similar products with minor redesign.
- Develop new technology, major redesign to replace large percentage of BOM
- Do not sell in the EU

### ❖ Outsource or Switch Suppliers:

- Tempe-based Circuit Research Labs[9] makes equipment used by radio and telephone stations to control their signal power. Circuit Research will outsource most of its manufacturing to facilities in foreign countries that already meet the RoHS standards. The company is closing a facility in San Leandro, CA and will lay-off the majority of the 50 employees working there.

### ❖ R&D and Full Redesign:

- [USA] Microchip Technology[10]spent millions to eliminate lead from its production by completely redesigning lead-coated pins that attach semiconductors to circuit boards.
- [USA] Intel Corp[11] spent 6 years, committing hundreds of people to removing lead from chips and circuit boards. *"Every part of the company has been affected by the change – from marketing to engineering."* – *Intel Sr. EH&S technologist.* The company will be completely lead-free in time to meet RoHS regulations.
- [EU] Nokia[12] began to comply immediately after the requirements were made public – replacing lead solder by designing a brand new composition.
- [EU] Renesas Technology[13] replaced 5 out of 6 banned substances on the RoHS list, but facilities have been working for years to replace lead-solder plating on package terminations. The price is the same for lead and non-leaded products.

### ❖ Proactive Implementation:

- Some Japanese companies were working on lead-free before RoHS and have experimented with consumer-marketing of "lead-free" products.
- US based Advance Circuits has been offering lead-free in multiple product lines[14].

### ❖ Dual Inventory:

- Arizona Microtek[15] will carry 2 different inventories – products with lead and another line of products that are lead-free.
- M/A-COM, in Lowell, MA (and parent company, Tyco International), is producing 'backwards compatible RoHS compliant components, which tolerate high-temperature processing required for RoHS compliant electronics, as well as continuing the standard product line for market sectors unaffected by RoHS

### ❖ Avoidance or go slow:

- Altera opted to not sell products in the EU.
- IBM's strategy is to be in pace with but not ahead of the industry as a whole[16].

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[i] Biviano (1999) "Total materials consumption: an estimation methodology and example using lead—a materials flow analysis" USGS

[ii] Bond, R., Jennings, N, (2005) "EU Environmental Laws Hit The Electronics Industry Hard." Faegre & Benson

[iii] Rivlin, K.S., Brisson, Wharwood, J. D., (2004) "WEEE and RoHS Directives: New Requirements Impacting the Global Supply Chain of the High-Tech industry."

[iv] Inside Washington Publishers: Risk Policy Report (2006), "California Lawmaker To Draft Bill Mirroring EU Toxic Ban."

[v] Such as higher temperature processing for lead-free solder (effecting all components), "tin whiskers", testing for banned substances, and product reliability

[vi] (IPC, JEDEC, NEMI, EIA, NCMS, IDEALS)

[vii] Study by National Center for Manufacturing Sciences (NCMS) The largest cross-industry consortium in the United States nearly 80 solder alloys in 1997.

[viii] The primary lead-free solder alloys are tin-silver-copper and tin-copper eutectic (or near eutectic) alloys.

[8] Agilent & Speedline Technologies to collaborate on Lead-Free Manufacturing Research Experiment, 2005

[9] [10] [11] [15] Lead Ban Creates "Huge Task" by Max Jarman—Arizona Republic, 12/26/2005

[12] [13] It's Not Only About Lead by John Mason—Electronic News, 12/9/05

[14] PCB Suppliers Feel the RoHS Pain by Ann Steffora Mutschler -- *Electronic News*, 12/7/2005

[16] Altera Product Line Manager Seminar in Europe, Edward Clarke, 2005