



TECHNOLOGY FORECASTERS INC.



Economic Impact of the European Union RoHS* Directive on the Electronics Industry

January 21, 2008

***RoHS:** Restriction of the Use of Certain Hazardous
Substances in Electrical and Electronic Equipment

Purpose of this Study

- **To calculate the economic cost of compliance with EU RoHS and associated impacts on the global electronics industry**
 - Study undertaken by third-party consulting firm experienced in this market
 - Impact measured by using an objective research approach
 - Analyzed both costs and business benefits



Who is Behind this Study

Consulting firm conducting the research

- Technology Forecasters Inc. (TFI) is a consulting and research firm founded in 1987.
- TFI Environment helps high-tech clients comply with all applicable environmental regulations and simultaneously realize significant competitive advantages and cost savings.
- The consultants are primarily based in the United States, with offices in Mexico, China, Japan, the UK, and France

Sponsor of the research

- The Consumer Electronics Association (CEA) is a trade association representing more than 2,200 companies in high-tech industry.
- CEA member companies are engaged in the development, manufacturing and distribution of all consumer electronics, communications and multimedia products and services that are sold through global consumer channels.
- CEA is located in Arlington, VA and is the producer of the International CES in Las Vegas.



Study Methodology

1. **TFI designed and conducted a web survey which included questions about EU RoHS compliance costs and procedures, as well as other existing substance restriction laws.**
 - Sent the web survey to more than 1,000 companies
 - 271 people started the survey, 205 completed it (76% participation rate)
 - The completed surveys were by...
 - 58% OEM, 16% component manufacturers, and 13% contract manufacturers (also called electronics manufacturing services (EMS))
 - 64% North America, 15% Europe, 12% Asia
2. **TFI designed a questionnaire for follow-up telephone interviews; interviewed 23 people**
 - Gave respondents opportunity to share detailed views on the compliance process
 - Obtained further details on costs
 - Took time and care to form relationship with respondents for consistent results



Study Methodology (Continued)

3. Analyzed all data (both quantitative from web-survey results/telephone results and qualitative from telephone results)
 - Compared results by the respondents' different geographies, industry sectors, types and sizes of companies, year began RoHS compliance, etc.
4. For the cost calculation specifically
 - Some outlying responses were culled
 - Analyzed responses from companies exempt from EU RoHS (“out of scope”) separately from those “in scope” (at top level)
 - Cross-correlated key data to company type or size
 - Extrapolated study's data to calculate total industry cost



In-Scope and Out-of-Scope

- Of the 205 responses, we were able to use 171* for cost-of-compliance calculations:
 - 48 were from companies exempt from EU RoHS (“out of scope”)
 - 123 were from companies “in scope”
- Counted companies not stating whether RoHS exemptions apply to them as “in scope.”
- “Out-of-scope” respondents are mixed bag
 - Some voluntarily complying--fully or partly
 - Some not complying, but still affected by discontinuation of non-compliant parts
- Cost calculations included both in- and out-of-scope, because each had individual RoHS-generated costs.



*34 incomplete responses removed

TECHNOLOGY FORECASTERS INC.

Results

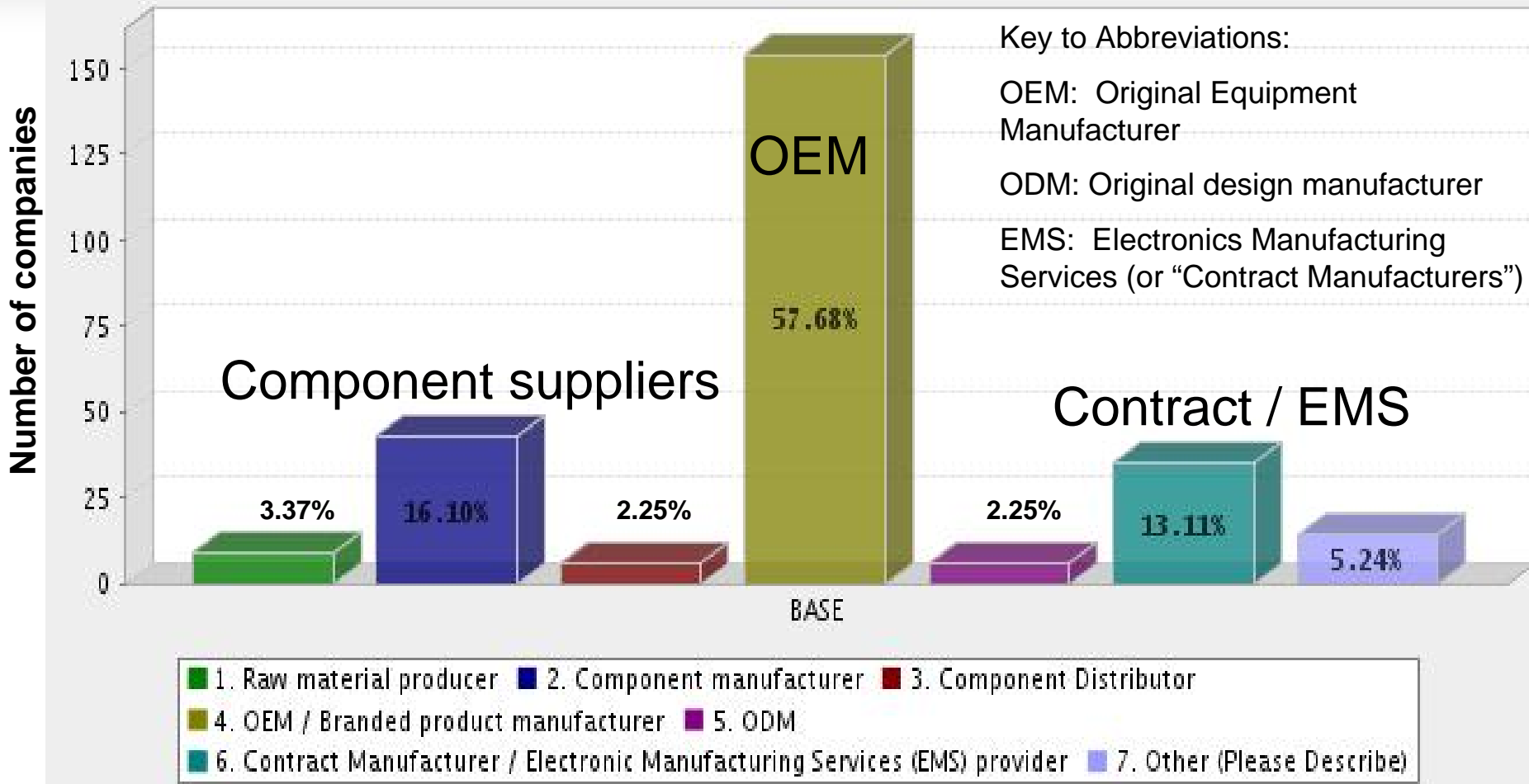


General Feedback on EU RoHS

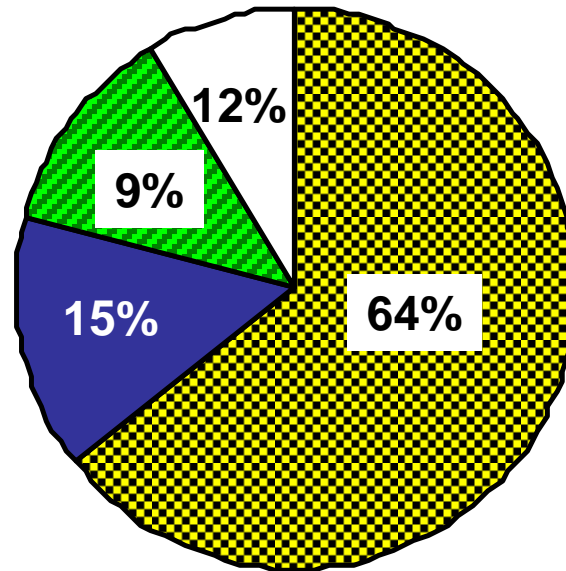
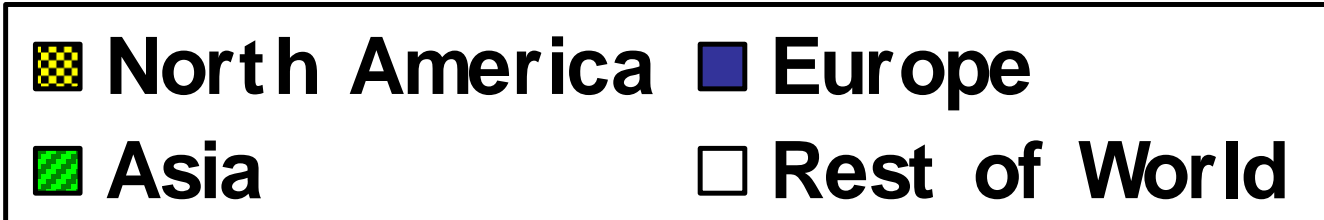
- **Several OEMs and EMSs expressed concern over other companies' (particularly suppliers') preparedness**
 - Suppliers weren't ready, didn't understand, or weren't competent at supplying materials data.
 - Several suppliers indicated that proving compliance to customers is challenging.
- **Companies criticize the RoHS directive itself**
 - *"I think the biggest struggle is trying to understand what the requirements are."* (Large North American EMS)
 - *"The directive itself was vague and unclear."* (Large North American OEM)
- **Several said complying with RoHS is "Time-consuming" or "Tedious"**



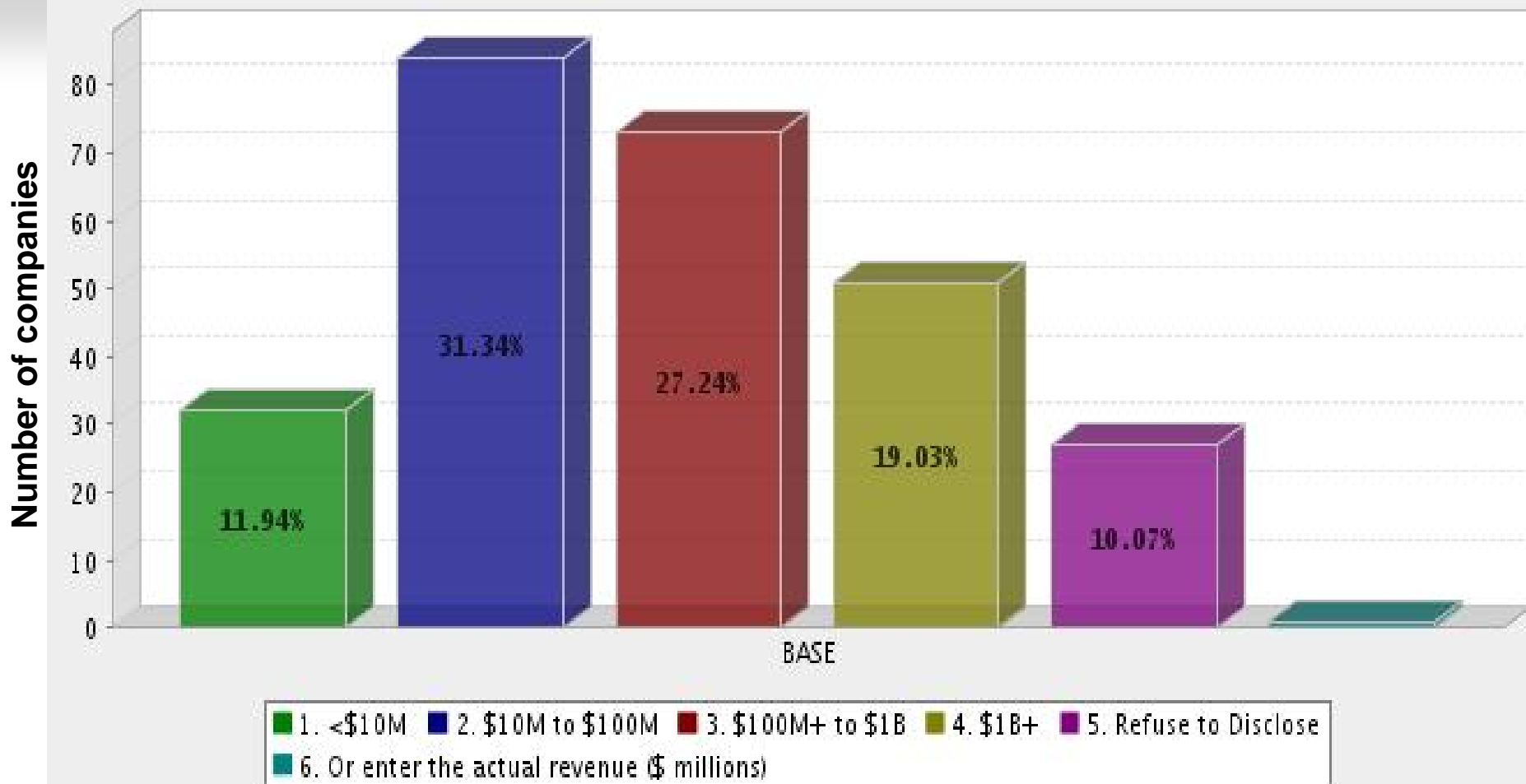
Type of Companies Responding to Study



Geographic Distribution of the Respondents' Headquarters Locations



Revenue of Respondents' Companies*

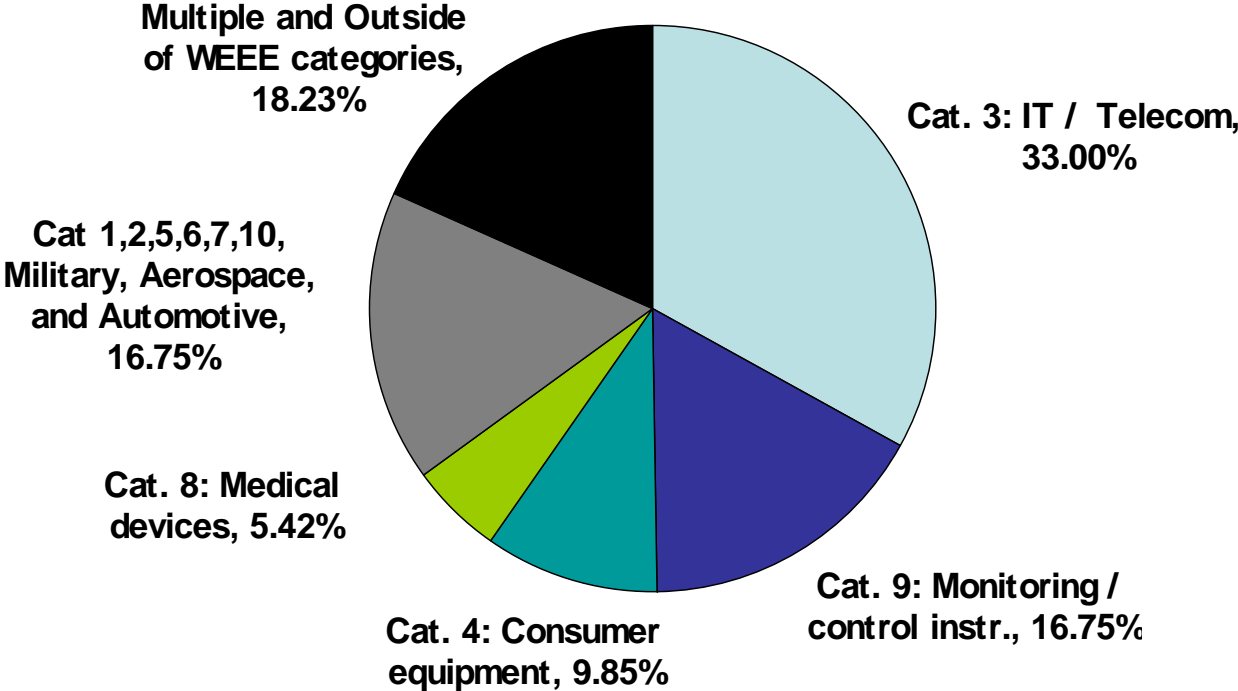


* From most recently completed fiscal year

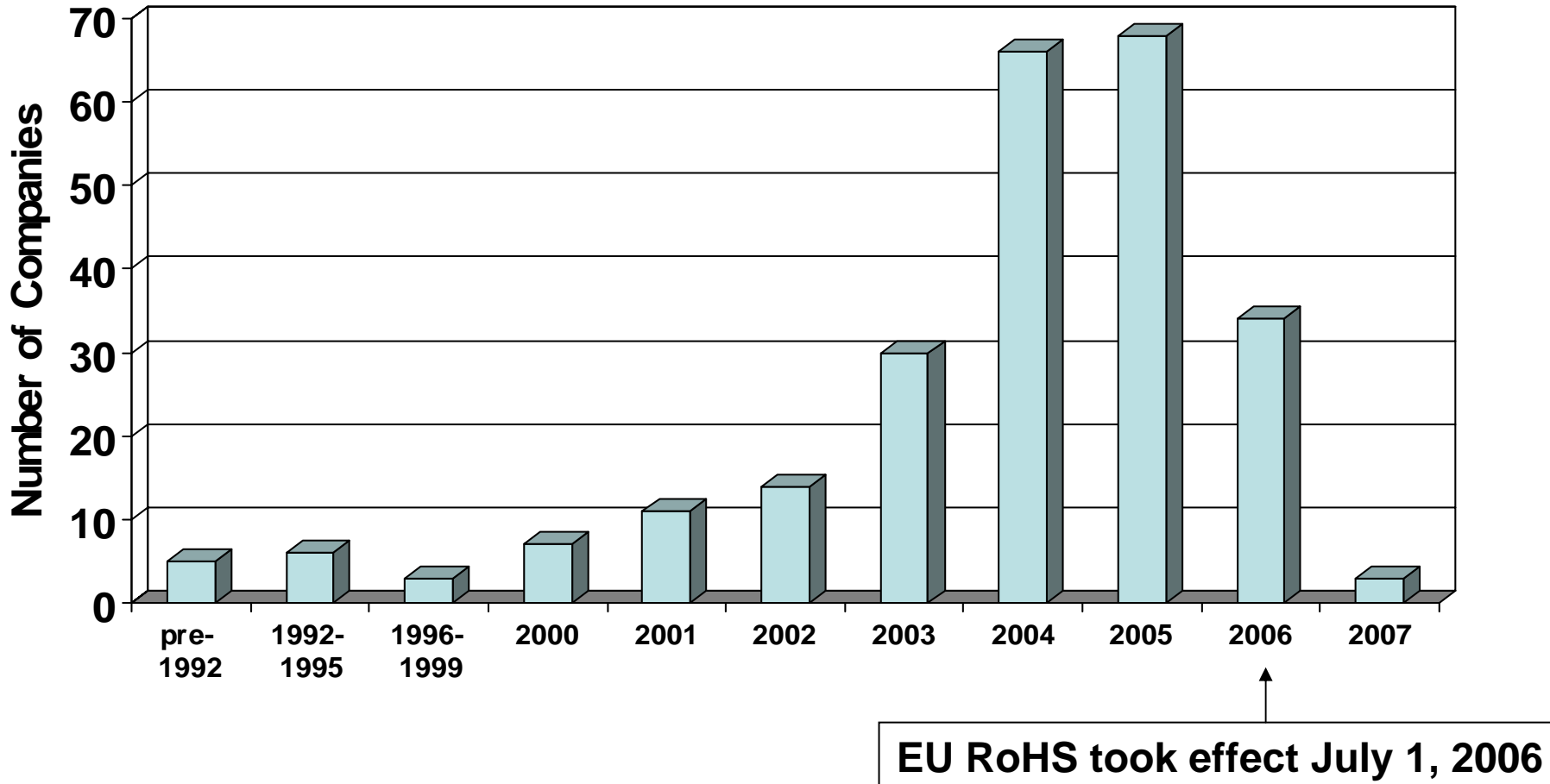


Primary Industrial Sectors of Respondents

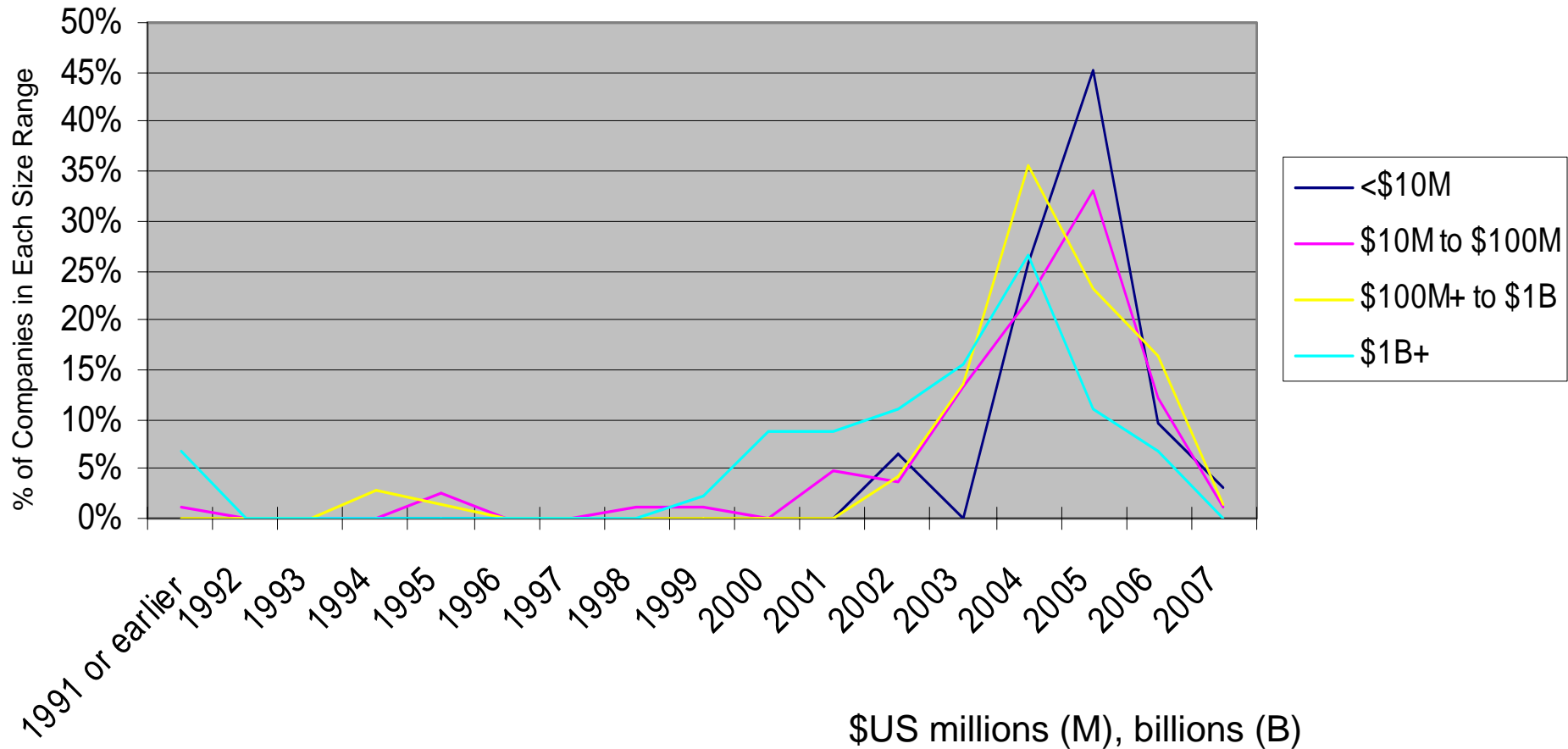
21% were currently out-of-scope (“exempt” from RoHS)



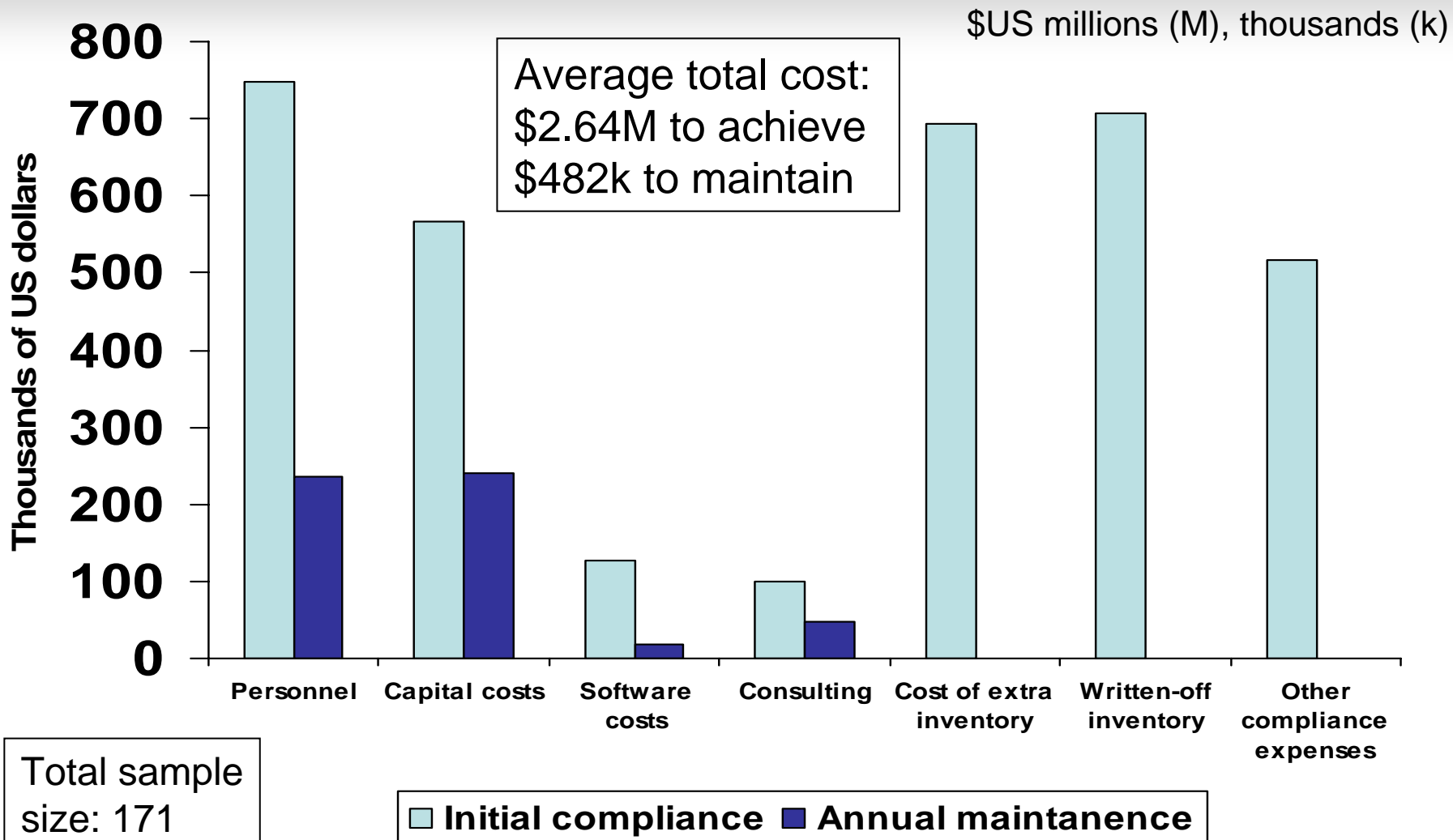
Year the Respondents Began Work on EU RoHS Compliance



Larger Companies Started Work on Compliance Earlier



Average Costs from EU RoHS Compliance



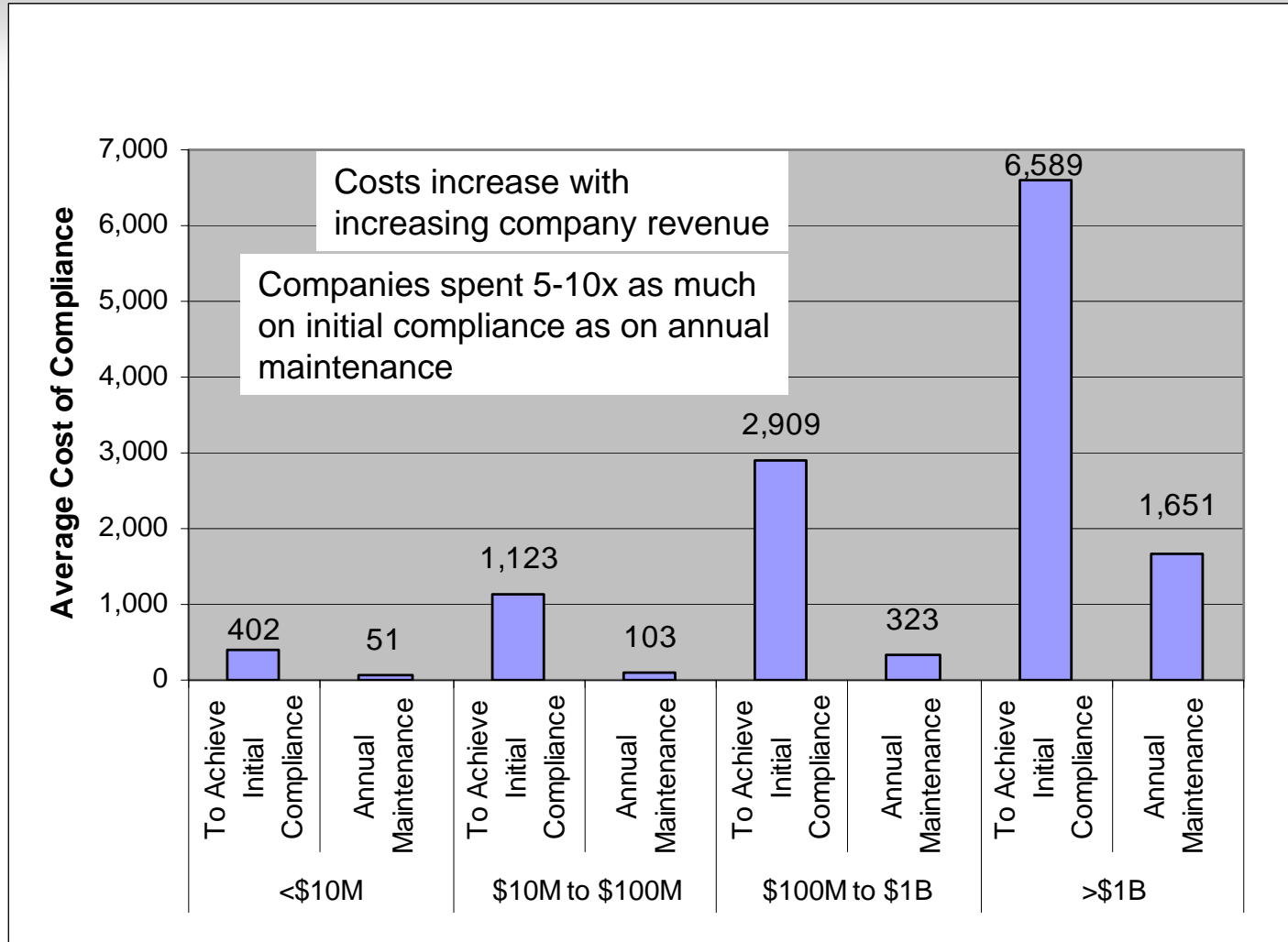
Average Cost vs. Median Cost and Weighted Average Cost

- Total average cost was \$2.64 million for initial compliance, \$482,000 for annual maintenance (based on our 171-company sample).
- Total median cost was \$721,000 for initial compliance, \$118,000 for annual maintenance (based on our 171-company sample).
- Total weighted average cost* was \$5.94M for initial compliance, \$1.44M for annual maintenance (based on our 171-company sample).
- Due to the effect of large companies with larger compliance costs:
 - The median is smaller than the straight average.
 - The weighted average is larger than the straight average.

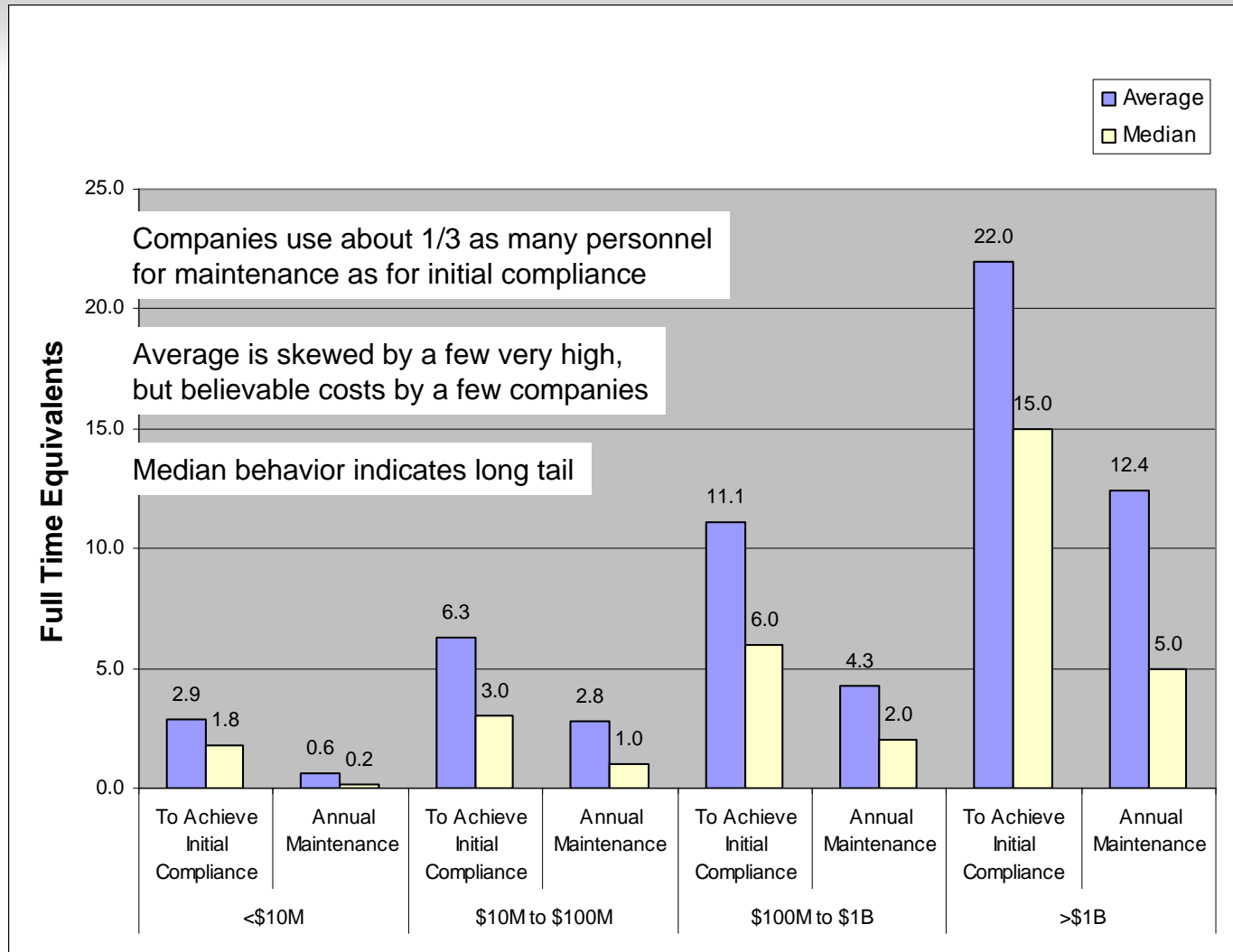
* Weighted by company revenue. Each revenue category was assigned an avg value (same as Slide 49)



Company Revenue vs. Average Cost for Compliance with EU RoHS (US\$ thousands)



Company Revenue vs. Average Number of Full-time-equivalent Employees



Adding/Retraining Personnel

The vast majority of companies hired zero or one employee for RoHS compliance, relying instead on internal resources.

- *“We’re still trying to invent the ways to get this done. We’re borrowing and reassigning people to get it done because you don’t get extra people.”* (Large North American OEM)
- *“This does not include the time and effort that was absorbed with the current headcount. Our people were stretched more thinly.”* (Medium-sized North American OEM)
- *“We tried to reassign existing people and expand their jobs. People worked overtime.”* (Large North American EMS)
- *“People were not added, but stolen from elsewhere and made to work harder... It was a long, hard row for a lot of people.”* (Large North American OEM)

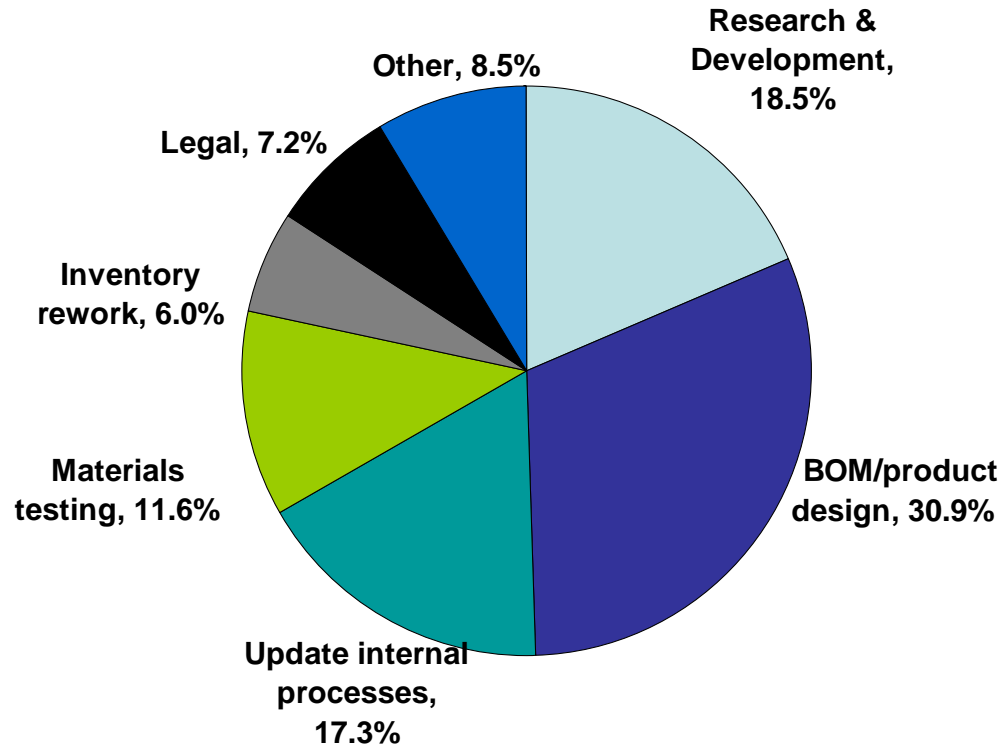


Reassigning Existing Personnel

- *“Some retraining and change of work tasks have been taking place. How many additional resources are hard to estimate, since the way of working has been changed to some extent at the same time. “ (Small European Contract Manufacturer)*
- *“Everything we touch affects the current process, so we had to get a lot of groups involved. We have a lot of heads working on the problem, so this does not include the cost involved with getting all these people together and the cost of taking them away from their current jobs. “ (Medium-sized North American OEM)*
- *“In the beginning, before the implementation, there were 2 reassigned people, and now there is 1 person. There was nothing added financially, but they were appointed (reassigned) to this project and tasked with taking care of the initiative.” (Large European OEM)*



Average Distribution of Compliance Personnel



BOM: bill of materials

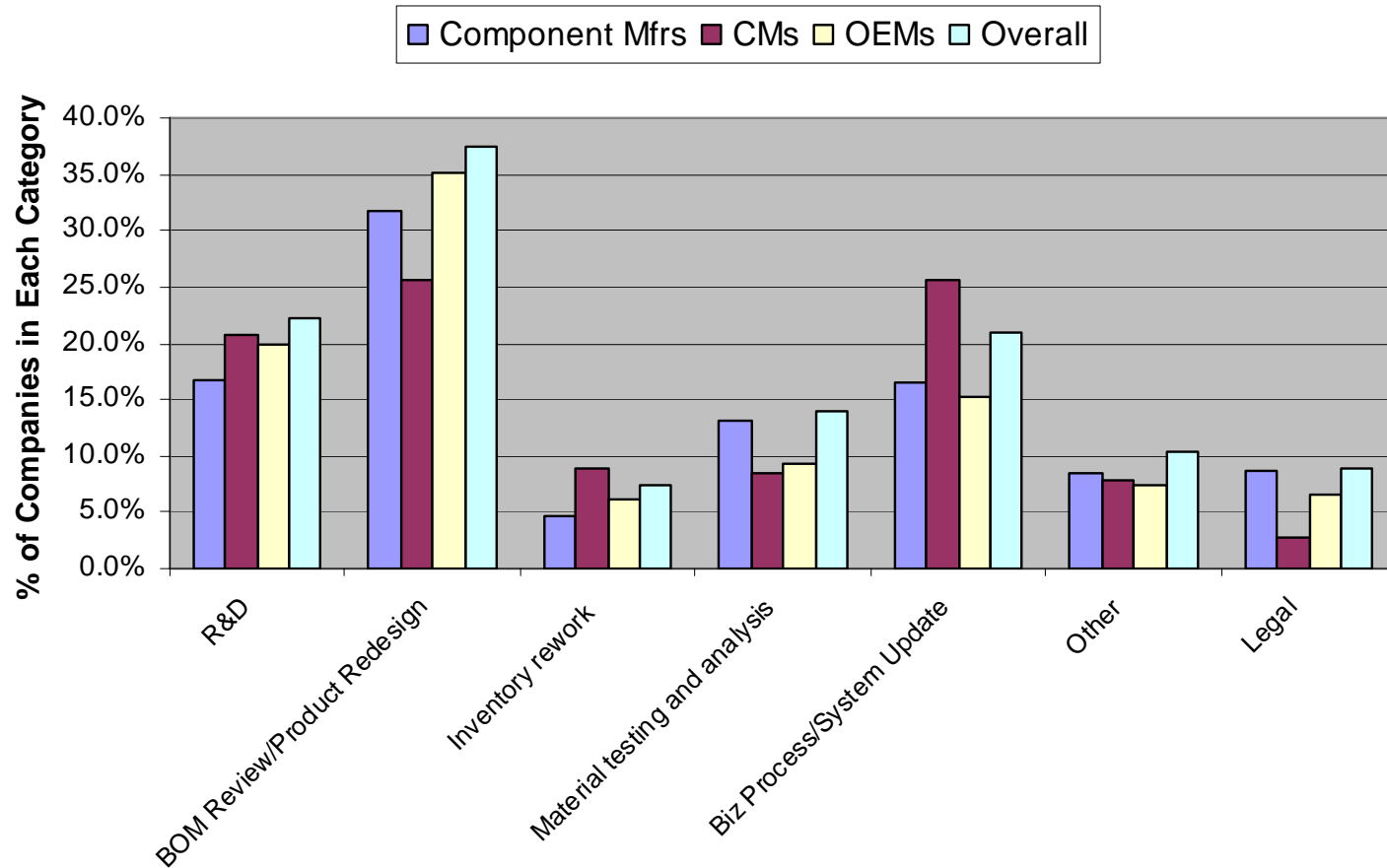


Personnel Analysis by Company Type

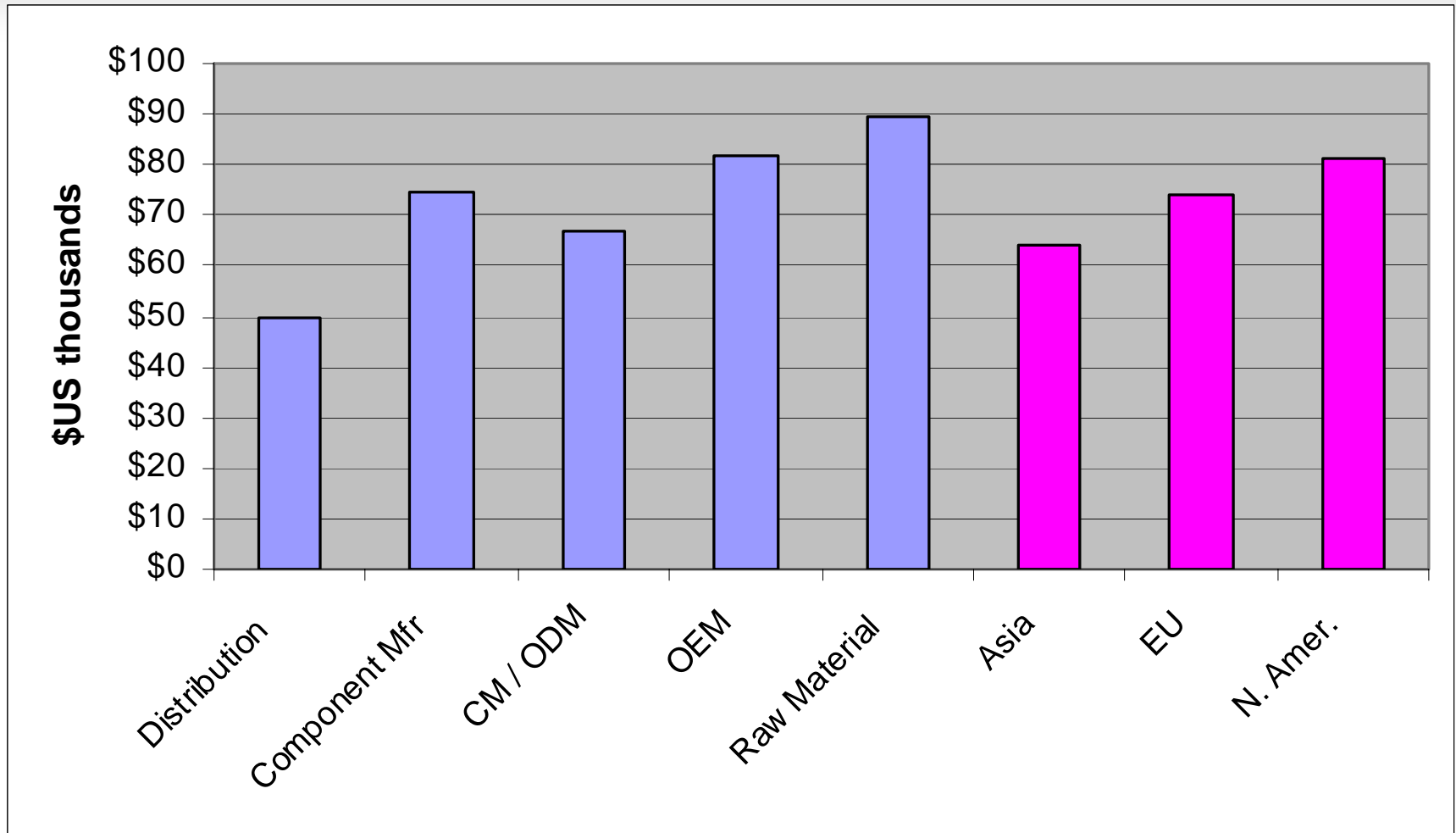
- **Contract Manufacturers (CM)/EMS had to spend the most effort on business process and system updates**
- **Component manufacturers and OEMs had to spend the most effort on BOM reviews and product redesign**
- **Everyone had an equal burden in R&D**



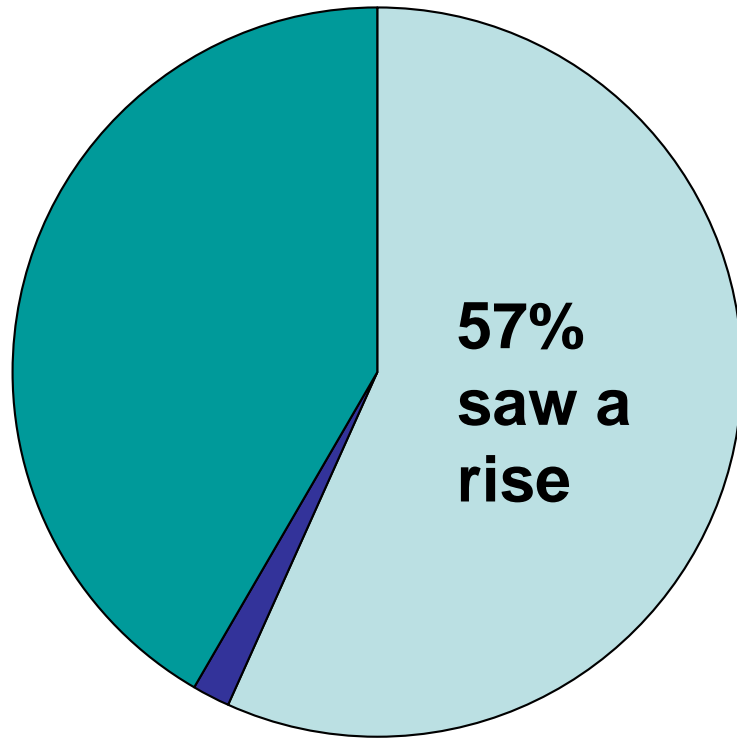
Where did RoHS Personnel Spend their Time?



Average Annual Personnel Cost by Industry Segment & Headquarters Location



Effect of EU RoHS on Inventory*



■ Increase ■ Decrease ■ No change/ Don't know

Avg reported rise over pre-RoHS inventory level: 21%

Avg reported cost of carrying this inventory: \$688,000

Avg reported value of scrapped or written-down inventory: \$698,000

* Raw materials, work-in-process, finished goods, spares



Interview Results: Inventory

Varied views; some companies were more proactive than others.

- *“It took about 6 months ramp up and then another 6 months to stabilize.”* (Large North American OEM)
- *“Everything pretty much stayed the same. We said to our customer: If you want these parts, here is your last ship date ... otherwise you will have to wait for the new stuff. Then we restricted them to ordering the new RoHS compliant products.”* (Medium-sized North American OEM)
- *“Every time there is an obsolete part, it changes the schematic, the BOM, everything-- it is a nightmare.”* (Medium-sized North American OEM)

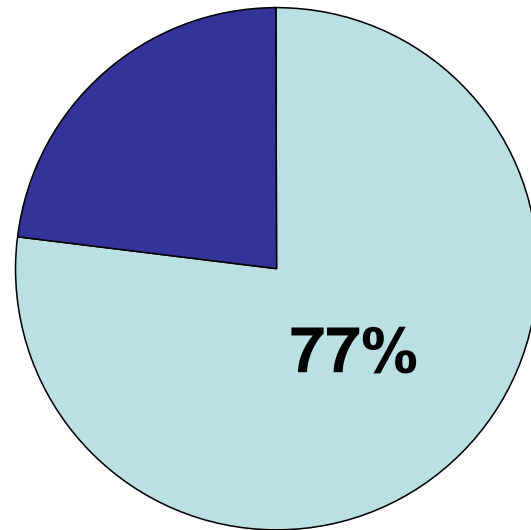


Interview Results: Inventory

- *“Because we started a whole year in advance, we did not have the peaks and valleys. We shifted the non-RoHS products to non-RoHS locations. Our goal was to be fully compliant by Jan 2006--6 months before the deadline. We pressured our suppliers to be compliant before Jan. 1 so that we did not have to carry a heavy inventory.”* (Large European OEM)
- *“We had perfectly good product, but our biggest market was the EU and we could no longer ship lead product there. We basically reserved against it and took it off our books.”* (Mid-sized North American OEM)
- *“We were very successful at mitigating our losses with our compliant vs. non-RoHS compliant inventory. This was not a losing proposition.”* (Large North American Contract Manufacturer)



Effect of EU RoHS on Component, Module, and Manufacturing Costs



Avg cost increase experienced (OEM) or added (ODM or EMS) = 11.6%

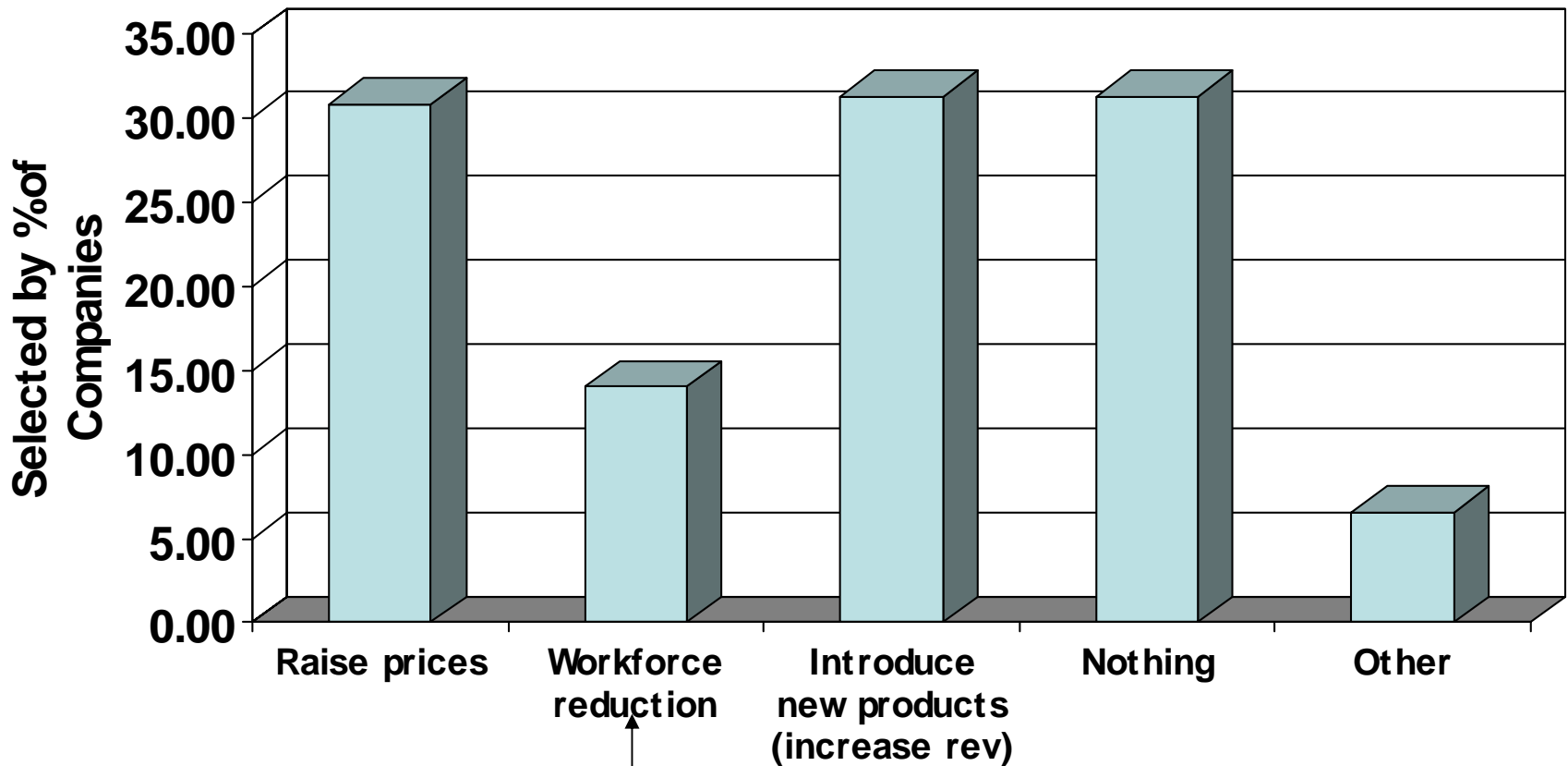
■ Increase ■ No change

(Three respondents reported a decrease)



What is Being Done to Recoup Costs?

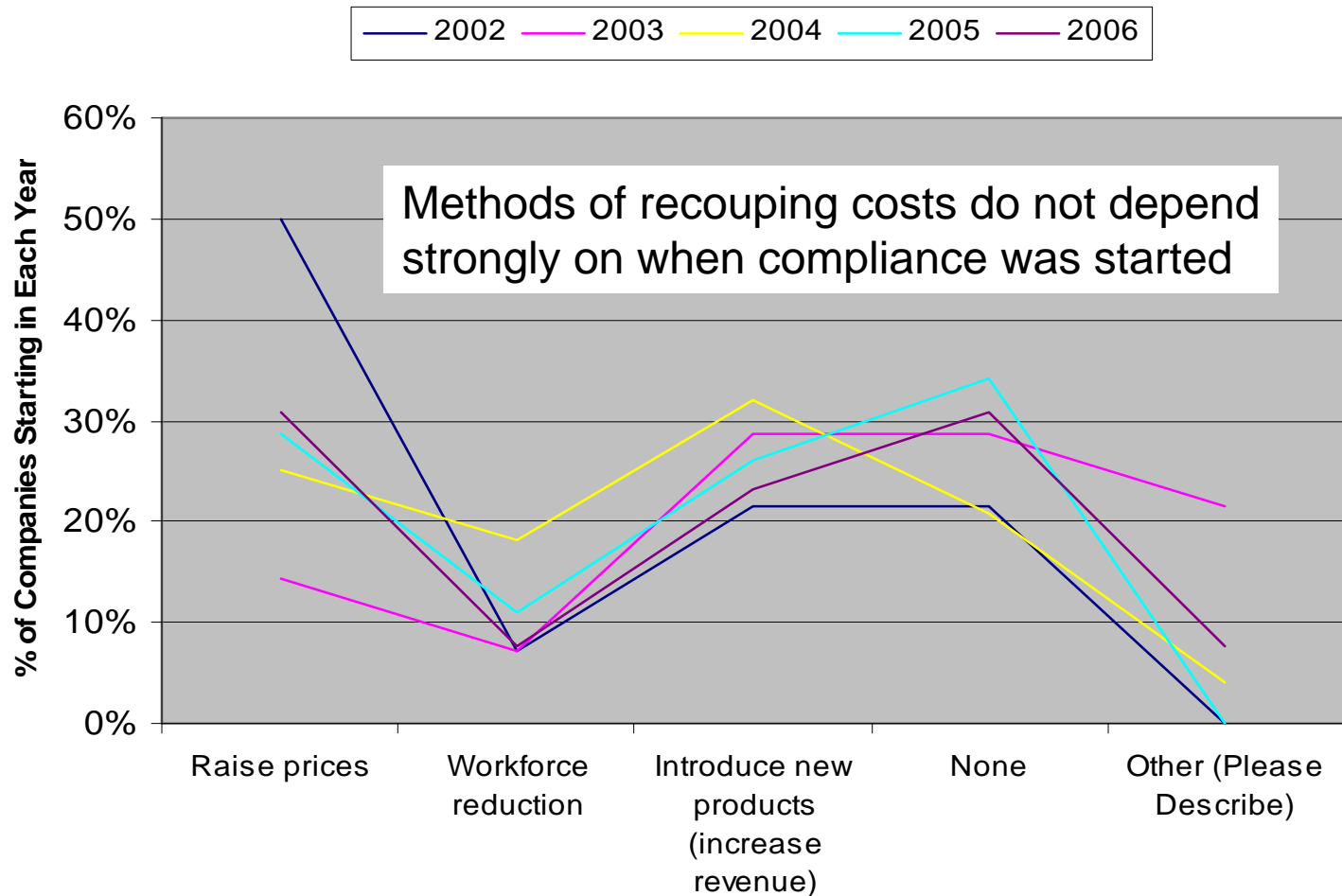
* Respondents could select more than one



Companies were less likely to reduce headcount than to choose other options, including doing nothing.



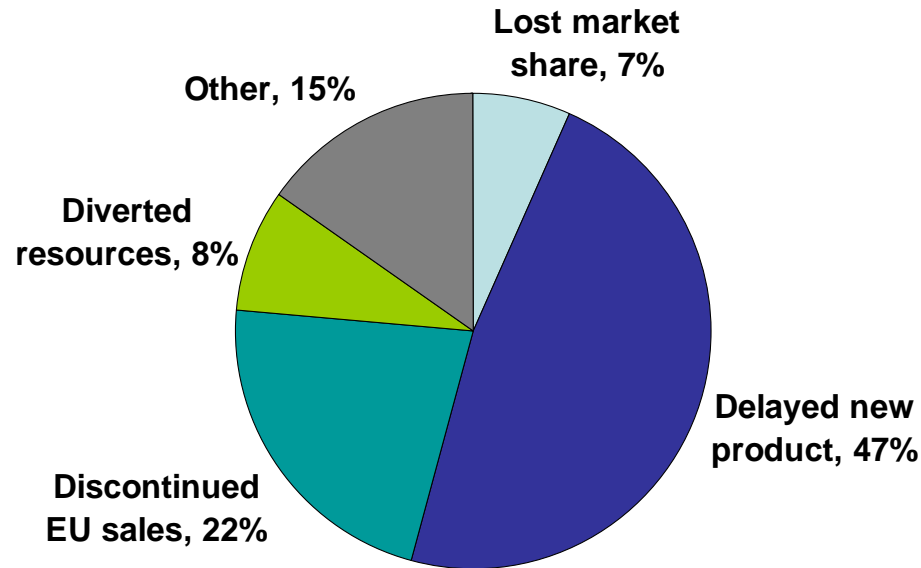
How Costs Have Been Recouped vs. Start Year



Lost Sales Due to EU RoHS

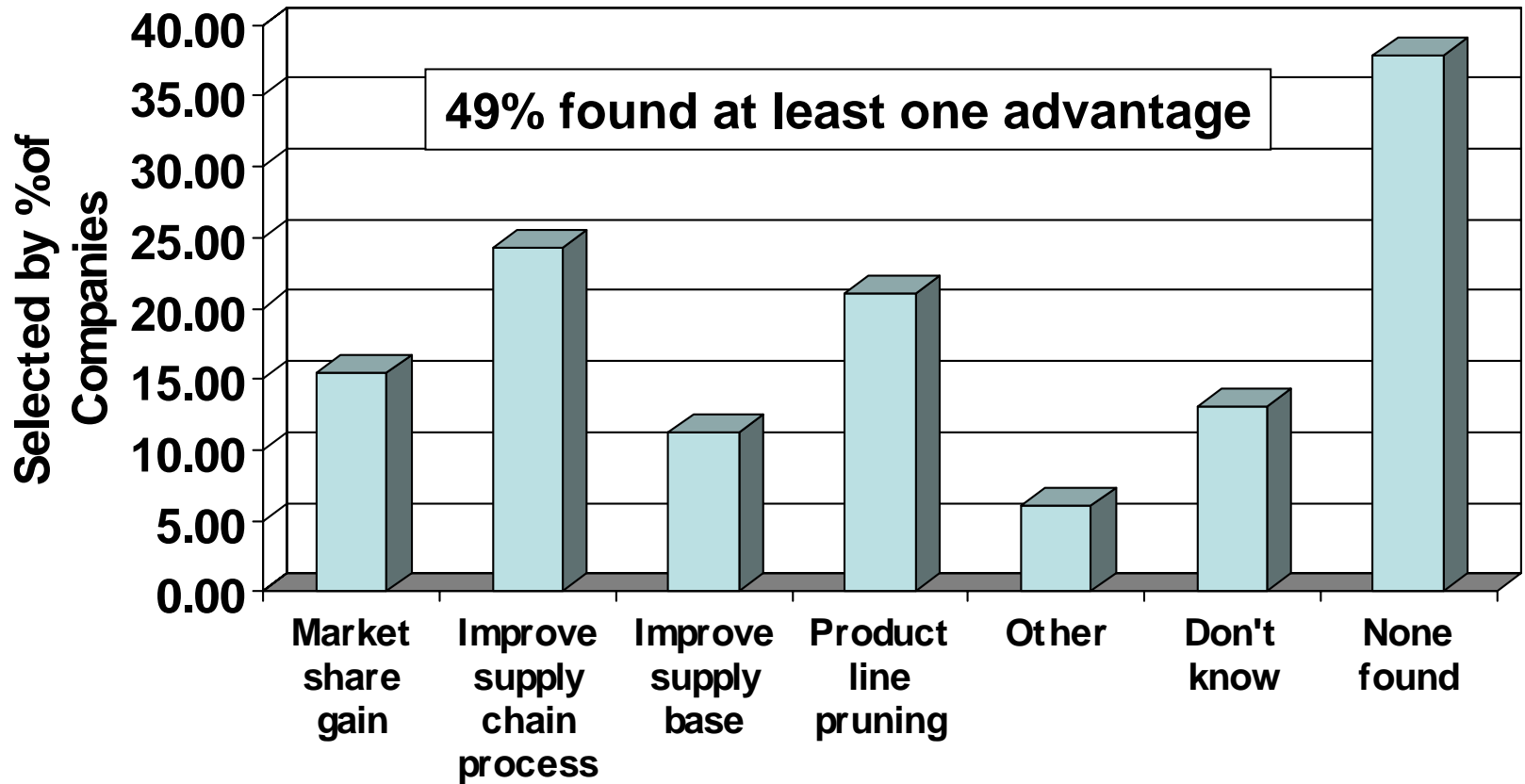
- Lost sales reported by 28.6% of respondents
- Average loss = \$1.84 million

Primary cause
of lost sales:



Advantages Discovered in Compliance Process

* Respondents could select more than one



Advantages Discovered in Compliance Process

“We redistributed non-compliant products to those locations that did not require RoHS. We also took the time to prune our inventory and some end-of-life inventory earlier, because it was cost effective at the time.”
(Mid-sized North American OEM)



Who Got the Advantages?

- **Main winners were EMS providers**
 - 75% found at least one advantage
 - 60% improved their supply-chain processes
 - 50% saw a market-share gain
 - 50% rationalized their product lines
- **Component manufacturers also fared well**
 - 70% found at least one advantage
 - 26% saw a market share gain
- **Half of OEMs found at least one advantage**
 - Of these, about half improved their supply chain processes (27% of total)



Comments on Sales

- *“We haven’t missed any sales because we didn’t have a lead-free product in time for the RoHS deadline. However, we did miss sales because of our inability to meet a deadline on having the lab reports required from the corporate customer. It’s significant, and nothing gets management’s attention as missed P.O.s.”* (Large North American OEM)
- *“We didn’t lose sales at all! If anything, we did well because of RoHS!”* (Large North American EMS)



Changes to Business Processes

- **Training & (continuing) Education across the company**
 - Some incorporate environmental objectives in to MBOs (MBO=management by objective, or job requirements)
- **R&D/Product Development (OEMs) – Revise component selection processes to include assessment of RoHS compliance**
 - Use of existing standards, like IPC 1752
 - For existing products, had to review parts in existing BOMs
- **Data Management – buy new or configure existing product lifecycle management (PLM) systems to manage and reflect data**
 - And update processes to enable use of the data
 - Often new part numbering systems were implemented at both supplier and OEMs
 - Often the cause of customer frustration for both



IT Systems Were Modified or Added

- *No new system purchased, “But we may have to buy something in the future because the regulations are getting too complex for our home-built system (it cannot handle the detail).” (Large North American Contract Manufacturer)*
- *“No new software, but our old software was modified. It took approximately 9 months to modify software to accept new part codes and include supplier data.” (Mid-sized North American OEM)*
- *“We purchased [a commercial] System at a cost of \$200,000, it cost \$10,000 to implement. The cost of annual upgrades is \$20,000....” (Mid-sized North American OEM)*



More Changes to Business Processes

- **Supplier Management/Procurement**
 - Make sure suppliers understand and manage environmental requirements
 - Identify replacements for those that do not
- **Manufacturing**
 - Changes to inventory management to segregate RoHS from non-RoHS items
 - Review/Change Design for Manufacturing (DfM) rules to reflect impacts (Pb-free solder, for instance)
 - EMSs needed to implement or change test and manufacturing processes and procedures
 - Occasional spot testing (XRF or other analysis methods)

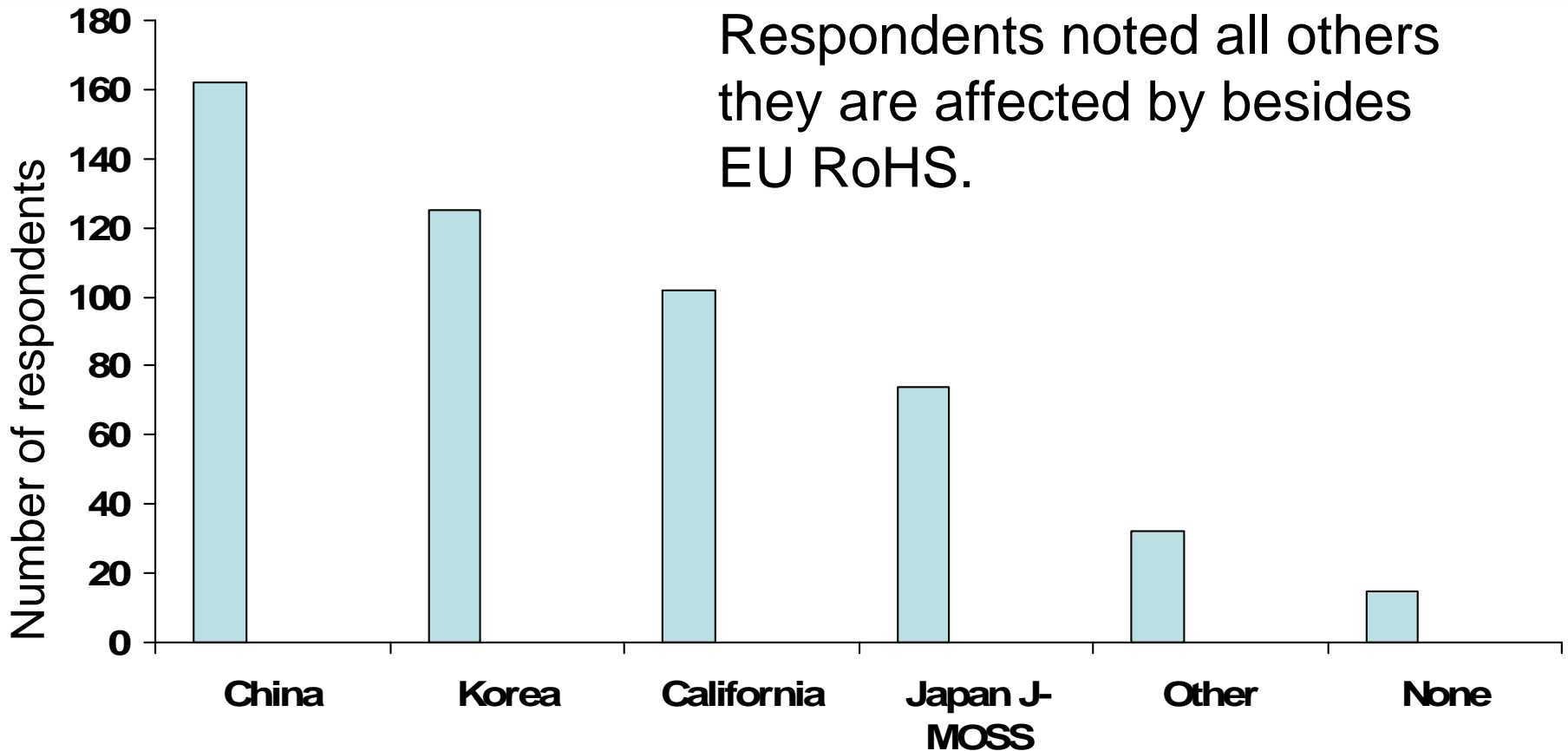


Pb = lead

EMS = electronics mfg. services

TECHNOLOGY FORECASTERS INC.

Other Substance Restriction Regulations



Other Substance Restrictions Regulations

69.4% said handling compliance with multiple RoHS directives brought additional costs.

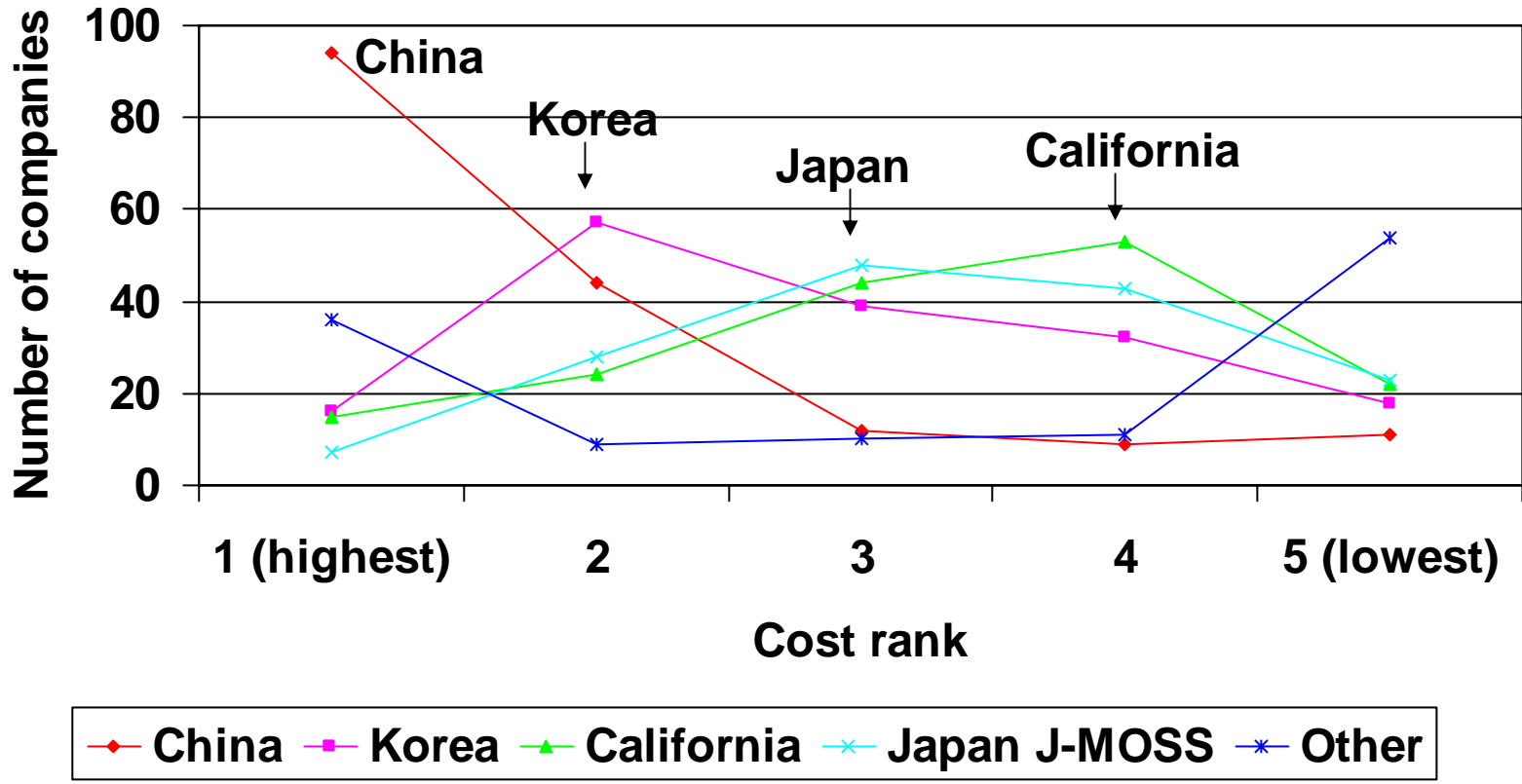
- *“So far there has not been any significant impact other than China with the labeling exercise. It was been about 2 man-years for China RoHS (sic.) alone.”* (Small North American OEM)
- *“China is probably the most difficult, because it is different. Many of the other countries are jumping on board with using the EU guideline.”* (Mid-sized North American OEM)
- *“After the internal processes have been altered for the first time, then the same structures can be used for subsequent laws too, so it’s not so bad.”* (Large North American OEM)
- *“China [is different]; they are imposing a specific marking, so we have to conform in some ways. We have a team in China so it is easy to understand. In the future...we will have to follow packaging regulations; I am also concerned about REACH*.”* (Large European OEM)



*Registration Evaluation and Authorization of Chemicals Regulation (EU)

TECHNOLOGY FORECASTERS INC.

Rank of Other Substance Restriction Directives by Cost Burden



What Would Help?

Multiple respondents suggested standards or centralization to simplify and streamline environmental behavior.

- *“Most of all, we want an international standard, and are working toward that end. We would also love a general resource (from CEA? from government?) to help companies comply. It is so challenging to keep up that we are simply in ‘reaction mode.’”* (Mid-sized North American OEM)
- *“Why not create an MBS similar to the automotive industry where there is a centralized database for the electronic industry?”* (Large North American OEM)
- *“The main thing that I would like to communicate is to get some harmonization in this thing, because it is challenging for us, everybody has something different.”* (Mid-sized North American OEM)



Taking the Long View

- *“I really appreciate all these directives. I have studied environmental sciences, and I am well aware how responsible we are for our health and for the planet. In following the directives, companies are really obeying the environment, not the EU, or Japan, or Korea, or California. I am proud to be helping the environment through my company.” (Small Asian component supplier)*



Regulations vs. Company's Overall Culture and Social Responsibility Goals

- *“As a repercussion of RoHS, we have taken a much greener stance in looking at environmental [proactivity]. We look at environmental things such as packaging, so I think that it has been a positive impact in that regard.”* (Mid-sized North American OEM)
- *“To be honest, I would definitely say that [our company's social responsible culture] is because of the regulations out there. We are a company that is trying to become greener.”* (Mid-sized North American OEM)
- *“We have our social responsibility goals that we sustain, but legislation has put it over and above ‘requirement’. So we went into this because of the requirement of the legislation and this accelerated the requirements.”* (Large North American OEM)
- *“I would say it was due to the requirement / regulations.”* (Large European OEM)



Estimated Costs for the Entire Industry



How We Applied Study Results to Estimate Total Industry Costs

- Used census and other public data to estimate total number of global electronics companies
 - 50,000 OEMs, 36,000 component suppliers, 3,000 EMS, 1,000 other (Total: 90,000)
- Reorganized these 90,000 companies into revenue categories using 2002 census data:

\$1B+
\$100M to \$1B
\$10M to \$100M
\$5M to \$10M
\$1M to \$5M
<\$1M

314
4,530
11,610
7,583
27,828
38,135

} Broke smallest category into three parts because average reported cost was higher than revenue of smallest companies.



How We Applied Study Results to Estimate Total Industry Costs (continued)

- Estimated US\$50,000 initial compliance, \$5,000 annual maintenance for revenue category \$1M-\$5M (million)
- Dropped companies with <\$1M revenue
- Used average costs from our survey for each category to multiply out the total cost:

	Extrapolated cost to achieve (\$k)	Extrapolated annual maintenance (\$k)
\$1B+	2,068,946	518,414
\$100M to \$1B	13,176,665	1,463,067
\$10M to \$100M	13,038,030	1,195,830
\$5M to \$10M	3,048,310	386,726
\$1M to \$5M	1,391,418	139,142



\$k = US\$ thousands

TECHNOLOGY FORECASTERS INC.

Estimated Total Industry Costs

- Cost to electronics industry to achieve EU RoHS compliance: **US\$32.7 billion (B)**
- Cost for annual maintenance: **US\$3.7B**
- Total cost of compliance to date* = **\$38.25B**



*Given that EU RoHS has been in effect for 1.5 years: 1.5 years \$3.7B

TECHNOLOGY FORECASTERS INC.

Estimated Total Industry Costs, by % Revenue

- Total revenue of electronics companies in each revenue category (assuming a smooth distribution weighted toward the lower end):

	Avg Revenue (\$k)	Total revenue for category
\$1B+	\$3,400,000	\$1,067,600,000
\$100M to \$1B	\$330,000	\$1,494,774,600
\$10M to \$100M	\$33,000	\$383,130,000
\$5M to \$10M	\$7,000	\$53,080,020
\$1M to \$5M	\$2,000	\$55,656,720
<\$1M	\$600	\$22,881,096

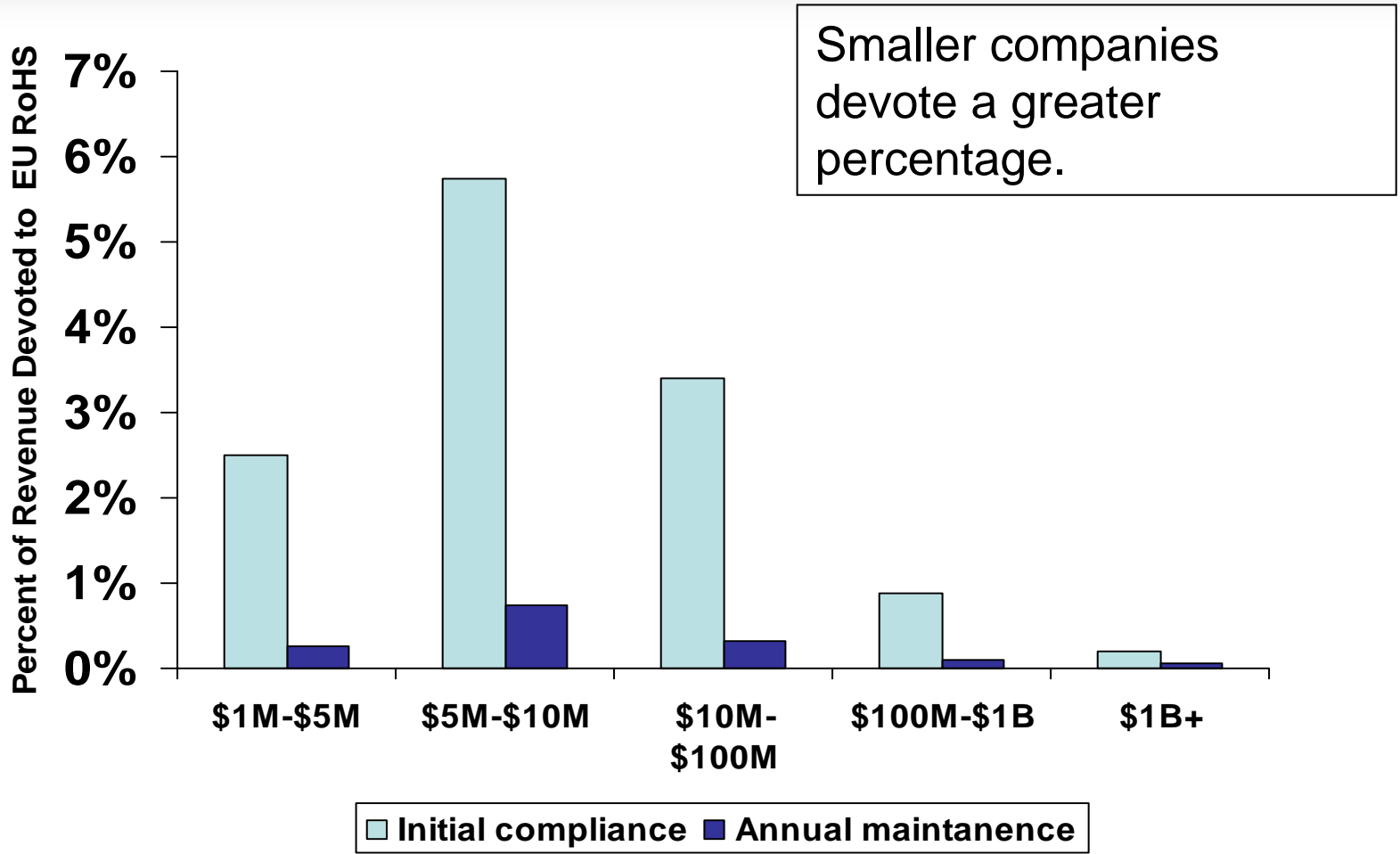
Calculated from data for \$1B+ category, then estimated for others.

Average revenue times number of companies in category

- Total compliance cost for the industry totals **1.1%** (average) of industry revenue
- Annual maintenance for industry **0.12% of revenue**



Estimated Total Industry Costs, by % Revenue



Opportunity Cost

- **Whereas 1.1% of revenue may not seem to be a large figure, let's consider the opportunity cost**
 - In other words, how could the funds have been spent to otherwise improve products?
 - On average, research and development (R&D) at electronics companies averages 4%-6% of revenue (much less for contract manufacturers)
- **In first-quarter 2004, TFI forecast the cost of RoHS compliance at 1.5% to 2.5% of electronics companies' cost of goods sold (COGS); this is roughly equivalent to the 1.1% of revenue costs indeed incurred.**



Summary



EU RoHS Compliance: Summary

- **TFI survey elicited data from 200+ companies.**
 - Well-balanced in terms of region, company type, and company revenue
 - Most began compliance work during 2003-2006, but a solid minority began earlier
- **Average total cost per company from our sample:**
 - \$US2,640,000 to achieve initial compliance
 - \$US482,000 annual maintenance
- **Companies required 5-10 full-time-equivalent employees for compliance, almost exclusively drawn from existing internal resources.**
 - Personnel represented the largest cost.
- **57% reported a rise in inventory at the initiation of RoHS (July 2006)**
- **77% saw increased component or module costs**



EU RoHS Compliance: Summary

- **29% reported lost sales due to RoHS (average loss US\$1.84 million)**
 - 2/3 of these came from delayed new product or discontinued EU sales
- **Nearly 50% reported at least one advantage from the EU RoHS compliance process**
- **Most companies are affected by substance restriction laws in other regions too**
 - China's substance restriction law was deemed the most challenging: Tedious labeling requirements and lack of clarity
- **Many companies longed for a more standardized set of directives to simplify compliance**



EU RoHS Compliance: Summary

- Estimated total cost to industry: approx. US\$32 billion for initial compliance (1.1% of industry revenue)
- Annual maintenance requires 0.12% of revenue
 - Generally from improving their supply chain process or pruning their product lines
- Much of the challenge lies in retraining, redesigning processes, etc. – Just what businesses must always do to stay in the game!



Contact Information

for people involved in this study

- **Consumer Electronics Association (CEA)**
 - Parker Brugge,
pbrugge@ce.org
 - Joanne Sonenshine,
jsonenshine@ce.org
- **Technology Forecasters Inc. (TFI)**
 - Pamela Gordon, C.M.C.,
pgordon@techforecasters.com
 - Mike Kirschner,
mike@designchainassociates.com
 - Kim Allen, Ph.D.,
kimall@mindspring.com
 - Anne Feith,
afeith@techforecasters.com
 - Holly A. Evans, Esq.
h.evans@cox.net

