

## Case study: Complying with Clean Product Mandates for the European Market

### Executive Summary

Economic impact implications for Massachusetts's firms affected by the 2006 implementation of EU directive for *Reduction of Hazardous Substances* (RoHS) in electronics imports stem from the following

- MA exports approximately \$2.6 billion annually of electronic manufactured products to Europe from NAICs- 334 and 335. This is 5.7% of the combined annual sales from these MA industries manufacturing *Computer & Electronics*, and *Electric Equipment & Appliances*
- EU marketplace since July 2006 has new laws banning the use of certain toxins in these products
- Product manufactures and their supply chains have incurred costs and continue to do so to comply with this law, in order to preserve/gain market share
- MA jobs tied to EU exports for these product areas are 4,000, and when considering the supply-chain jobs for MA another 5,450 are involved.
- Labor income to the 4,000 export-related jobs for NAICS 334 and 335 indicates well paid positions – with fringe, an average of \$113,250 per worker. The state's average is \$57,475.
- MA consumer spending from the labor income created by sales of product into the EU will also support more job, income and business sales creation.

If continued transition to becoming compliant with a directive such as RoHS poses firm-level difficulties and export sales are forfeited, then more jobs are at risk in the state's economy. If this is so, a case could be made for the state to offer assistance to those industries adjusting to new regulations/market directives – such as with the Toxics Use Reduction Act (TURA) adopted in 1989.

### Introduction

There is a current regulatory trend, nationally and internationally, towards requiring that products be manufactured using less toxic or polluting materials and processes. The EU's RoHS and other regulations are the beginning of a shift in this direction that in all likelihood will continue. Markets dictate all aspects of product demand – from function, price, durability and safety concerns. The implementation of the European directive "*the restriction of the use of certain hazardous substances in electrical and electronic equipment*" (EU RoHS) in July of 2006 established new product fabrication requirements for electrical equipment and electronics offered in the EU marketplace. While EU RoHS has been in effect for just a short time, the directive was announced well in advance to prepare global manufacturers, resellers and distributors to meet the upcoming safety requirements for continued product sales into the EU.

Businesses must respond to regulatory or market driven changes or else they fail. Clean Tech: An Agenda for a Healthy Economy, is exploring several areas (regulatory and voluntary) to achieve greater occupational and consumer safety, cleaner (reduced waste streams and pollution)/more efficient production, healthier (less toxic) - resource efficient buildings/workplaces, and clean-renewable energy production and adoption. When businesses understand the value of particular market segments, occupational and consumer health risks associated with the manufacture or use of their product(s), they can proactively change the way they conduct business, and safeguard or increase market share.

### **Brief Background on EU RoHS**

The RoHS directive is perhaps most identified with its *lead-free* requirements for electrical equipment and electronics sold in the EU market as of July 2006. However the directive targets the elimination of six hazardous materials found in electrical and electronic products – *lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls* and *polybrominated diphenyl ethers*. The latter two have been in use as flame retardants. The law provides for certain temporary exemptions, including control and monitoring equipment, national security use and military equipment, medical devices and, spare parts for electronic equipment in the market before July 1, 2006.

Firms must comply if they sell applicable electronic products, sub-assemblies or components directly to EU countries, or indirectly (through resellers, distributors or integrators) to EU countries.

Since the definition and implementation of the EU RoHS directive, China and Korea have implemented similar regulations, state-mandated changes regarding *waste from electrical equipment & electronics* have been adopted (California), and several other nations are in the process of advancing similar regulations (Australia, Canada, and Taiwan).

## Affected Portion of the MA Economy

The RoHS directive explicitly affects Massachusetts' manufacturers of electronic equipment and electronics that are destined as exports (or plan to) to the EU. The export sale may be conducted by the manufacturer or through a reseller or distributor channel. In all cases, compliance obligations reside with the manufacturer.

Indirectly, there are likely other Massachusetts manufacturers of products not covered by the RoHS directive (regardless of whether they export or not) which incorporate some electronic component (e.g. toys). Since the electronic component supply chain is very likely adjusting to RoHS requirements, these manufacturers will likely experience changes in the supply network. This may include inventory delays, product line elimination, changes in the component costs, or the reward of being the first to market with cleaner products before any regulation mandates such modifications. This case study does not attempt to assess such tangential implications RoHS has on other MA-based manufacturers.

**Exhibit 1: RoHS Targeted Industries in MA -- Job Generators in 2006**

	NAICS Code	Description	Establishments	Jobs	Salary per Job	Sales per Job ( <i>labor productivity</i> )
	<b>334</b>	Computer & Electronics MFG	727	69,501	\$118,056	\$648,734
Exempted	334510	<i>Electromedical Apparatus</i>	37	6,285	\$65,130	\$251,085
Exempted	all 334- sub-sectors	<i>Defense-related products</i>	-	4,364	-	-
	<b>335</b>	Electrical Eq. & Appliance MFG	215	11,246	\$87,853	\$339,953
Exempted	all 335- sub-sectors	<i>Defense-related products</i>	-	124	-	-

*Sources:* IMPLAN data (U.S. BEA and CBP data reconciled); salary includes fringe benefits; establishment data are 2005 from CBP; dollars are 2006 basis

Exhibit 1 shows the number of establishments and jobs for Computer and Electronics Manufacturing, and Electrical Equipment and Appliance Manufacturing- NAICS 334 and 335 respectively. These two industries offer well paying positions justified by the high labor productivity demonstrated by their employees (the average sales-per-job across all MA industries is approximately \$149,000 - less than half as much as the low range observed across NAICS 334 and 335). Also shown in Exhibit 1 is information for the likely sub-sectors exempted under RoHS. Approximately 14% of the jobs across NAICS 334 and 335 are associated with manufactures of exempted products under RoHS. Since military electronic products, one of the exempted sectors, do not simply correspond to the manufactures from a single NAICS area, the portion of annual production from NAICS 334 and 335 into (U.S.) military procurement was determined by examining the allocation of Federal Defense spending in MA<sup>1</sup> across all sectors. We use the U.S. Federal military procurement profile as a proxy for EU military procurement.

<sup>1</sup> Available in the IMPLAN model which has been calibrated to Massachusetts data.

**Exhibit 2: 2006 Sales and Export Markets for Massachusetts NAICS 334 & 335**

NAICS Code	Description	Annual Sales (mil.)	Total Exports (mil.)	% of Sales	Exports to EU (mil.)	% of Sales
334	Computer & Electronics MFG	\$45,088	\$7,520	16.7%	\$2,173	4.8%
334510	<i>Electromedical Apparatus</i>	\$1,578	\$465	29.5%	\$205	13.0%
all 334- sub-sectors	<i>Defense-related products</i>	\$3,923				
335	Electrical Eq. & Appliance MFG	\$3,823	\$872	22.8%	\$222	5.8%
all 335- sub-sectors	<i>Defense-related products</i>	\$42				

Sources: Sales from IMPLAN data (U.S. BEA and CBP data reconciled); Exports from U.S. Census Foreign Trade Division; dollars are 2006 basis

While the share of statewide employment accounted for by the businesses in NAICS 334 and 335 is approximately 1.7 and 0.3 percent respectively, their sales share for all sales in Massachusetts is 7.4 and 0.6 percent respectively. Exhibit 2 shows that almost 23 percent of the sales for *Electrical Equip & Appliance MFG* (NAICS 335) are destined for export markets. The importance of the EU as an export market for these MA-based manufacturing activities is demonstrated by export shares of 25% of NAICS 335 total export dollars, and 29% of NAICS 334 total export dollars. The EU is clearly an important part of business growth strategies for MA-based firms in these two manufacturing areas.

Within NAICS 334 RoHS exempted products are contained in the sub-sector NAICS 334510 – *Electromedical apparatus manufacturing*. Sales for this sub-sector in 2006 comprise approximately 3.5% of NAICS 334 sales, and its global exports accounts for 6.2% of NAICS 334 MA exports. This sub-sector is export intensive, particularly to the EU with 44% of its sales in Europe.

The economic *foot-print* of the RoHS non-exempted portions for these two industries gets larger when you consider the involvement of other parts of the Massachusetts economy that support them, creating “indirect” and “induced” impacts. Indirect impacts result from business-to-business transactions (along a supply chain) and the induced impacts result from workers (in NAICS 334 and 335) spending their take-home wages at in-state businesses that fulfill consumer (household) spending. The magnitude of added *economic linkages* with other Massachusetts firms are described as *multiplier effects*<sup>2</sup>. The tool used to measure these impacts is the IMPLAN (*input-output*) Model which has been used by agencies within the Commonwealth - MA DOER and the Massachusetts Technology Collaborative. A description of this impact system is provided below.

<sup>2</sup> These effects are both state-specific and industry-specific and available from IMPLAN MIG, Stillwater, MN to describe employment, sales, and labor income impacts among other concepts.

***About the IMPLAN MA Input-Output Model:***

IMPLAN is the most widely used analysis tool for measuring or estimating the economic impacts associated with openings, closings, expansion, contraction, and on-going operations of facilities – ranging from industrial plants to national parks. It shares three fundamental features also found in the other two commonly-used economic impact tools within the U.S. (RIMS-II multiplier data and the REMI model):

- It is based on the national input-output technology tables, developed by the US Dept. of Commerce, Bureau of Economic Analysis. This shows how each type of industry relies on a different mix of its own labor and supplies purchased from other industries.
- It is calibrated to reflect local economic patterns (of employment, payroll and business sales) occurring within specified counties (or sub-county areas). This shows a *default* on the extent to which local industries purchase goods and services from suppliers located within the same county.
- It distinguishes the direct effects from indirect and induced (spin-off) effects and measures them in terms of jobs, income, value added and business sales (output).

Each IMPLAN model is calibrated by the vendor with region-specific *industry-level* data (currently for 2006). Besides containing a NAICS code based industry database at the 3- and 4-digit levels (describing employment, sales, productivity, average compensation) the main capability of the IMPLAN model resides in its input-output core. The core combines the structure of relationships between industries, between industry and types of final demands arising in the region, the extent of local supply (or conversely *import dependence*) to meet local product demand, and the role of trade with the rest of the world.

The mechanism of multiplier analysis follows from the input-output relationships whereby the activity of a specific type of manufacturing in state creates a) requirements for supplies for goods and services (including capital improvements) from various industries; and b) earnings of workers in the manufacturing plants becomes disposable income for spending predominantly in state. Some portion of the initial economic stimulus from the manufacturing activity creates additional in-state transactions for supplies, creating jobs and more household income. When the entire sequence is completed (and progressively more dollars leak out of state) the total impact, in terms of jobs, is compared to the jobs directly related to the manufacturing facilities and a multiplier relationship has been defined. This relationship is also stated in terms of income and business sales as well.

**Exhibit 3: Economic Impacts for the MA Economy from *non-exempt* NAICS 334 & 335**

	<b>Jobs</b>	<b>Sales (mil.)</b>	<b>Income (mil.)</b>
NAICS 334 & 335 (non-exempt)	69,974	\$43,368	\$7,967
indirect (supply-chain)	95,491	\$25,840	\$7,160
induced (household spending)	109,814	\$16,470	\$5,299
<b>Total Impact</b>	<b>275,280</b>	<b>\$85,677</b>	<b>\$20,426</b>
<b>Impacts apportioned based on MA NAICS 334 &amp; 335 sales in EU market</b>			
NAICS 334 & 335 EU sales	4,003	\$2,395	\$453
indirect (supply-chain)	5,448	\$1,424	\$402
induced (household spending)	6,270	\$909	\$298
<b>Total Impact</b>	<b>15,721</b>	<b>\$4,728</b>	<b>\$1,153</b>

The top portion of Exhibit 3 depicts MA jobs, sales and labor income for non-exempt segments of NAICS 334 and 335, regardless of whether they export or not, and the impacts created through supplier transactions and household spending. The supplier transactions stimulated by activity from NAICS 334 and 335 support larger sales and labor income generation than household spending does. Impacts from household spending accrue to businesses in industries that have lower labor compensation-per-worker (\$48,254) since the activities in those industries require lower labor productivity (sales-per-worker). Put another way, the businesses that fulfill household spending needs tend to be more labor intensive which is why almost 109,814 jobs are created in comparison to 95,419 jobs created with the supply-chain transactions.

The lower portion of Exhibit 3 considers the portion of Massachusetts' non-exempted industry activity in NAICS 334 and 335 that is tied to sales in Europe. The 4,003 jobs represent EU export-related employment in firms that produce manufactured products listed in the RoHS directive. They are associated with another 11,718 jobs in the MA economy, added sales of \$2,333m and added labor income of \$700m. If successful compliance with the EU RoHS directive was not achieved, these latter results describe the magnitude of jobs, sales and labor income statewide that might be vulnerable (assuming business could not be readily grown in alternate markets).

Exhibit 4 shows which industries in MA benefit most by being in the supply chain transactions initiated by production from NAICS 334 and 335. There are seven unique industries to which 97% of the indirect job creation accrues. All but two of these industries provide workers with annual earnings at or well above the 2007 average annual pay of \$57,475<sup>3</sup>.

<sup>3</sup> Available through the Massachusetts Dept. of Labor website, labor market information link.

**Exhibit 4: Key Supply Chain Industries in MA  
linked to Production from NAICS 334 and 335**

	Share of Indirect Jobs	Avg. Earnings per impacted Job
<b>NAICS 334</b>		
541 Professional- scientific & tech svcs	19.81%	\$79,258
42 Wholesale Trade	15.97%	\$78,337
334 Computer & oth electron	11.82%	\$111,816
<i>subtotal NAICS 334</i>	<b>47.60%</b>	
<b>NAICS 335</b>		
541 Professional- scientific & tech svcs	17.56%	\$78,193
493 Warehousing & storage	2.44%	\$48,630
484 Truck transportation	2.93%	\$49,332
42 Wholesale Trade	17.56%	\$79,770
334 Computer & oth electron	2.44%	\$104,984
326 Plastics & rubber prod	4.88%	\$56,764
325 Chemical Manufacturing	1.95%	\$102,768
<i>subtotal NAICS 335</i>	<b>49.76%</b>	

**Potential Costs of Compliance**

When RoHS was enacted in 2003, industry trade groups and supply chain consultants quickly tried to assess what compliance would cost the affected industries. One consulting group initially (June 2006) estimated that U.S. electronics manufacturers would spend \$3.5 billion towards achieving compliance, and more recently (April 2008) published survey results (of 200 companies) that indicate \$32 billion has been spent (approximately 1.1% of industry revenue).<sup>4</sup> Research by AMR a supply chain consultant (2006) has estimated that between 2006 and 2011 nearly \$30 billion will be spent by the U.S. electronics industry on compliance. This assumes an average company cost equivalent to 3% of revenues.<sup>5</sup> The added costs are associated with product design, process changes, higher component costs from suppliers, delayed sales as a result of shallow inventories of RoHS compliant components, higher inventory carrying costs associated with both compliant and non-compliant product lines, and potential lost sales.

The reality since for U.S. industries affected by RoHS, and particularly those in Massachusetts, is at the moment difficult to pin-point. Technology Forecasters Inc. survey of 200 U.S. electronics manufacturing firms is just that – a sample. As will be discussed further on, we have yet to identify a Massachusetts or regional entity that is tracking the extent of lost sales into the EU due to compliance difficulties as of July 2006. From the sample of 200 U.S. firms 29% have incurred lost or delayed sales into the EU – averaging \$1.84 million per firm. On the positive side, proactive first-mover firms are citing advantages such as improved supply chain processes (25% of those surveyed), rationalized product lines (20%) and increased market shares (15%). Another piece of evidence<sup>6</sup> attributes additional regional growth for firms in Eastern Europe and China delivering surface mount technology manufacturing due to responsiveness to lead-free requirements in the EU.

<sup>4</sup> Technology Forecasters Inc. was quoted in both *Tech firms face EU toxics test*, Boston Globe (6/2006), and *Survey: RoHS Costs at Over \$32 billion*, <http://pcdandf.com> (4/2008)

<sup>5</sup> AMR also cites that a cost equivalent to 6% of revenues might be the case.

<sup>6</sup> Frost & Sullivan, 2006 – *Lead-free to Spur Equipment Industry*, <http://smt.pennet.com>

## Extent of Compliance Problems for MA firms

In discussions with several MA agencies and trade groups<sup>7</sup>, there is no formal data being tracked of changes in firm-level sales to the EU since July 2006. During the pre-implementation interval (2003 to 2006) articles in the trade press cited examples elsewhere in the U.S. of businesses that knew they would not be ready in time for the July 2006 deadline and as a result had to suspend existing sales in the European market<sup>8</sup>. In Massachusetts, M/A-Com (part of Tyco Electronics Corp.) announced that they were not only ready but saw this as a competitive opportunity to differentiate their product around the attribute of *safer products*. Post implementation there has been little tracking of export losses or gains that can be attributed to the EU RoHS directive (the exception being the release of the 2008 Consumer Electronics Association survey results of 200 U.S. OEMs, electronic manufacturing services and component manufacturers performed by Technology Forecasters, Inc.. The results were discussed at the end of the prior section.)

Examination of time-series export sales data for these two industries may offer some insight. The U.S. Census Foreign Trade Division reports annual export to specific markets (the EU) in *nominal* (unadjusted for inflation) dollars. Without making several adjustments (for inflation, exchange rates) to the year-by-year values one can not assess trends in *real* trade movements. However examining the trend in Massachusetts' share of U.S. exports (for NAICS 334 and 335 shown in Exhibit 5) to Europe over time (1997 through 2007) there appears to be competitive export issues (relative to other states) facing MA-firms in *computer & electronics manufacturing* that predate the advent of the EU RoHS product requirements.

**Exhibit 5: MA share of U.S. Exports to the EU – NAICS 334 & 335**

	NAICS_334	NAICS_335
1997	7.4%	4.57%
1998	7.8%	5.09%
1999	8.7%	4.91%
2000	9.2%	5.29%
2001	8.8%	6.20%
2002	8.0%	5.85%
2003	7.0%	7.00%
2004	6.4%	7.14%
2005	5.9%	7.30%
2006	5.7%	7.53%
2007	5.7%	7.71%

*Source:* U.S. Census, Foreign Trade Division; shaded portion of the annual series refers to industry definitions based on 1997 SIC code; 2006 denotes RoHS in effect starting July.

The MA share of U.S. exports to the EU has exhibited volatility well before July 2006. NAICS 335 has shown MA firms have recovered from sporadic declines in their share of U.S. exports to Europe. The gradual and persistent decline in the MA share after 2000 for NAICS 334 is more complicated to unravel. This pattern may very well be attributed to the solid footing Asian firms have established in saturating the world market for computer and electronic manufactures, as well as a small part from redefining some production activity out of computer & electronics

<sup>7</sup> MA Manufacturing Extension Partnership, MA Alliance for International Business, MASS Export Center, and American Electronics Association – MA division.

<sup>8</sup> Palm, Apple and IBM.

manufacturing and into another type of manufacturing. (*Note:* The trend for U.S. exports to the EU market for NAICS\_334 from 2002 through 2007 has been positive growth (based on kg exported). As mentioned above, there appears to be competitive export issues (relative to other states) facing MA-firms in *computer & electronics manufacturing* that predate the advent of the EU RoHS product requirements.

### **Nature of the Transition to RoHS**

The pre- and post-implementation responses by the affected firms under the EU RoHS directive (and some firm-level responses are no doubt still emerging) are relevant to gauging how other MA-based industries may respond to new end-market criteria concerning safer materials, energy conservation, and waste reduction. Regardless of the mechanism which instigates product change (governmental regulation or a market determined preferences), both play out at the firm-level. And since an industry will be comprised of different size firms, the overall industry-level response says something about the organizational resources and market strength each firm leverages (or not) to meet new product requirements. Collaboration among industry members and research institutions may speed the success in finding cost-effective replacement technologies which do not alter the product's reliability.

Those responses are not instantaneous. As noted in *Lead-free Electronics Industry* (TURI, 2006), short-term strategies might include *opting to be a first-mover* (the firm has the resources and perceives there is market share to gain by complying first); *abandon market position temporarily* until it becomes more affordable (to comply) to sell again into the market segment. Longer-term, a firm may decide it needs to *forfeit market segment permanently* with the chance that the firm can gain share in the non-compliance markets. The drawback however with this approach is that (a) suppliers may eventually eliminate product lines of cheaper, non-compliant components, and (b) other parts of the global marketplace are following the EU example and defining legislation or already implementing similar product requirements.

### **Conclusion**

The above examination has focused on the level of economic activity tied to manufacturing firms in Massachusetts making *Electrical Equip & Appliance* products and *Computer & Electronic* products, and activity they create for in-state suppliers. These two industries produce a majority of products listed in the RoHS directive for compliance. There are no doubt other Massachusetts firms apart from the above two industries which are manufacturing components and are also affected. An example is the jacketing and insulation that is part of wiring cable for electronic applications (NAICS 325991 –*Custom Coating Compounds* within Chemical MFG). However this level of specificity in what they manufacture (at a six-digit NAICS level) when using publicly available data sets as above, prevents an explicit examination of the necessary data (firm counts, jobs, sales to firms that will export to EU). The above analysis while not being able to *segment* the supplier-related impacts into affected and non-affected supplier businesses, does account for the *backward* economic requirements that fall to Massachusetts firms as well.

To frame the state's economic exposure if *non-exempted* firms in these two industries can not meet the product compliance requirements into the European market, we have also portrayed Massachusetts' impacts based on the predominance of sales to Europe in the overall annual sales for each of the two industries. Until the entire global marketplace was to adopt similar requirements, this approach acknowledges that Massachusetts firms would not be entirely at-

risk if some portion of their sales (export sales to Europe) were stranded. However an in-state (non-compliant) component manufacturing firm selling globally to assembling/manufacturing customers, who make significant sales to Europe, may sooner feel the necessity for achieving compliance in related components.

There are success stories among MA firms which either envisioned these product regulations eventually coming into effect, or were already (voluntarily) re-designing safer production/products as part of their corporate market strategy, or perhaps they are effective first movers. An industry-level impact analysis can not reflect the firm-level productivity increases that Massachusetts is host to. Only when these firm-level innovations permeate and help to transform the industry – exempted and non-exempt firms alike- would these become apparent. The above results are therefore conservative.