

INFORM

Strategies for a better environment

Waste in the **W**ireless **W**orld: The Challenge of Cell Phones

Bette K. Fishbein

INFORM, Inc. ©2002

INFORM, Inc.
120 Wall Street
New York, NY 10005-4001

Tel 212 361-2400
Fax 212 361-2412
www.informinc.org

Gina Goldstein, Director of Publications
Emily Robbins, Production Editor

© 2002 by INFORM, Inc. All rights reserved
Printed in the United States of America

ISBN #0-918780-78-0

INFORM, Inc., is a national non-profit organization that identifies practical ways of living and doing business that are environmentally sustainable. INFORM is supported by individual, foundation, government, and corporate contributions, and by book sales. All contributions are tax-deductible.

Contents

	Acknowledgments	i
	Introduction.....	1
	Findings and Recommendations.....	5
1	Cell Phones: An Overview.....	13
	Cell Phone Market Share	13
	Cell Phone Standards	14
	Makeup and Environmental Impacts of Cell Phones.....	15
	<i>The Printed Wiring Board.....</i>	<i>15</i>
	<i>The Liquid-Crystal Display</i>	<i>16</i>
	<i>Other Cell Phone Components.....</i>	<i>17</i>
2	How Many Phones? How Much Waste?	19
	Cell Phone Penetration.....	20
	Estimating Cell Phone Penetration and Numbers of Phones in Use.....	21
	Estimating Cell Phone Sales and Numbers of Phones Retired.....	21
	Stockpiled Cell Phones	22
	How Much Waste?	22
	Wireless Waste in Perspective.....	23
3	The Toxic Content of Cell Phones and Other Wireless Devices.....	25
	Persistent, Bioaccumulative Toxins: A US EPA Target.....	25
	<i>Dangers of PBTs.....</i>	<i>25</i>
	Toxic Substances Targeted by Companies.....	26
	Brominated Flame Retardants.....	26
	<i>Environmental and Health Impacts.....</i>	<i>27</i>
	<i>Regulating the Use of Brominated Flame Retardants</i>	<i>29</i>
	<i>Industry Efforts to Eliminate Brominated Flame Retardants</i>	<i>30</i>
	<i>Other Efforts</i>	<i>31</i>
	Lead.....	31
	<i>Lead in Municipal Solid Waste</i>	<i>31</i>
	<i>Environmental and Health Impacts.....</i>	<i>32</i>
	<i>Replacing the Lead in Solder.....</i>	<i>32</i>
	<i>Industry Efforts to Eliminate Lead from Solder</i>	<i>33</i>
	<i>Debate Continues on Lead-Free Solder</i>	<i>35</i>
	Other Hazardous Materials	36
	<i>Beryllium</i>	<i>36</i>
	<i>Tantalum</i>	<i>36</i>
	<i>Arsenic.....</i>	<i>37</i>
	<i>Copper</i>	<i>37</i>

4	End-of-Life Management of Electronics in the US	39
	Programs to Refurbish and Reuse Cell Phones	40
	Recycling of Cell Phones and Other Wireless Devices.....	41
	Voluntary Manufacturer Take-Back Initiatives.....	43
	<i>Computer Take-Back by Manufacturers.....</i>	43
	<i>Take-Back by Manufacturers of Other Electronic Equipment.....</i>	44
	<i>Analysis of Manufacturer Take-Back Schemes.....</i>	45
	Retailer Take-Back	47
	Trade Association Involvement in End-of-Life Electronics.....	47
	Corporate Give-Back	48
	National Electronics Product Stewardship Initiative	48
	Government Action on End-of-Life Electronics	49
	<i>Minnesota.....</i>	49
	<i>Massachusetts</i>	50
	<i>California.....</i>	51
	<i>Advance Disposal Fees and Landfill Bans.....</i>	51
	<i>Other Local Initiatives</i>	51
5	End-of-Life Management of Electronics Abroad	53
	Components of an Effective EPR Program	53
	Europe's Twin Directives on Electronic Waste	54
	<i>Directive on Waste Electrical and Electronic Equipment</i>	54
	<i>Directive on the Restriction of the Use of Certain Hazardous Substances in</i>	
	<i>Electrical and Electronic Equipment</i>	55
	<i>WEEE and RoHS Directives: Outstanding Issues.....</i>	55
	The EU's Directives Are Spurring Innovation	56
	Other EPR Models Abroad	57
	<i>Switzerland's Take-Back Program</i>	57
	<i>The ECTEL Project: A Voluntary Industry Program.....</i>	58
	<i>EPR in Japan</i>	58
	<i>Cell Phone Take-Back in Australia.....</i>	59
6	Powering Wireless Electronics: Rechargeable Batteries	
	and Alternative Technologies	61
	Rechargeable Battery Waste.....	61
	Rechargeable Battery Technologies.....	61
	<i>Market Share</i>	61
	<i>Performance Characteristics</i>	62
	<i>Material Composition</i>	63
	Alternative Power Sources	64
	<i>Hydrogen Fuel Cells</i>	64
	<i>Zinc-Air Batteries.....</i>	66
	<i>Solar-Powered Batteries.....</i>	66
	<i>Muscle Power</i>	67
	<i>Environmental Impacts of Alternative Power Sources.....</i>	68

End-of-Life Management of Rechargeable Batteries in the US.....	69
End-of-Life Management of Rechargeable Batteries Abroad.....	71
<i>EU Directives</i>	71
<i>National Legislation in Europe</i>	71
<i>Asia</i>	71
7 Looking Toward the Future of the Wireless World	73
Untethering the Internet.....	73
<i>Locator Functions</i>	73
<i>Wireless Connecting and Networking</i>	74
<i>Beyond Voice Communication</i>	74
<i>Monitoring the Body</i>	75
<i>Wearable Computers</i>	75
<i>Kids Go Wireless</i>	76
<i>Accessories</i>	76
Convergence versus Differentiation	76
The Throwaway Cell Phone.....	77
Short-Term Phone Rentals.....	79
Kodak's Throwaway Camera: A Model for Reuse/Recycling	79
The Challenge for Cell Phones.....	80
Notes	81
Appendix A: EPA's Draft List of PBTs Commonly Found in Hazardous Waste.....	91
Appendix B: Denmark S/D Vendor Questionnaire.....	94
Appendix C: The Ericsson List of Banned and Restricted Substances.....	95
Appendix D: Advertisement for Best Buy's Take-Back Program	99
Appendix E: National Electronics Product Stewardship Initiative (NEPSI) Members	100
Appendix F: Product Stewardship Institute Members.....	102
Appendix G: Massachusetts Resolution on Electronics Take-Back	103

Tables and Figures

Table 1.1	Market Share of US Wireless Service Providers, Dec. 31, 2001	13
Table 1.2	Global Market Share of Cell Phone Manufacturers, 2001	14
Figure 1.1	Environmental Impacts of Cell Phones.....	16
Table 2.1	US Cell Phone Subscribers, 1985 to 2001	19
Figure 2.1	Worldwide Cell Phone Penetration, as of year-end 2000	20
Table 2.2	Estimated Cell Phones in Use in the US, 2005	21
Table 2.3	US Cell Phone Sales, 1995 to 2004.....	21
Table 2.4	Estimated Number of Cell Phones Retired Per Year in the US.....	22
Figure 3.1	Uses of Brominated Flame Retardants.....	26
Figure 3.2	Consumption of Brominated Flame Retardants in Electronic and Electrical Products	27
Table 3.1	Total Market Demand for the Major Brominated Flame Retardants, 1999	28
Figure 3.3	Management of Plastic Wastes Containing Brominated Flame Retardants in Europe	29
Table 3.2	Melting Temperature of Different Types of Solder.....	32
Table 3.3	Relative Costs of Lead Substitutes in Solder	35
Table 4.1	End-of-Life Electronics Management: US Manufacturer Programs vs. the EU's WEEE Directive.....	46
Figure 6.1	Cellular Industry Market Share of Three Types of Rechargeable Batteries	62
Table 6.1	Characteristics of Three Types of Rechargeable Batteries	63
Table 6.2	Hazardous Content of Three Types of Rechargeable Batteries	64
Table 6.3	Ni-Cd Battery Recycling in the United States and Canada	70

Acknowledgments

I am grateful to the many people from industry, government, and nonprofit organizations cited in this report who not only provided information but also took the time to answer my many questions relating to cell phones and other hand-held wireless electronic products.

A particular note of appreciation is due to Alicia Culver, Laura Truettner, and Lara Sutherland of INFORM's Chemical Hazards Prevention Program for their input on the toxic substances in cell phones and the risks these pose to the environment and public health. Thanks also to Duncan Bury of Environment Canada for providing the results of research done in that country on the hazardous content of electronic products, and to Naoko Tojo of Lund University in Sweden for providing up-to-date information on the status of initiatives for managing end-of-life electronic equipment in Europe and Japan. Invaluable research assistance was provided by INFORM researchers Eric Most and Patrick Barnhart and interns Todd Pollak and Lloyd Jones.

Very special thanks to Gina Goldstein for her significant contributions in the editing of this report, to Emily Robbins for the design and layout, and particularly to INFORM President Joanna Underwood for her support and valuable suggestions.

Finally, I want to thank the US Environmental Protection Agency, Region II, and the Summit Foundation of Washington, DC, for their financial support of this project. This report, however, does not necessarily reflect the views or policies of either of these funders.

Bette K. Fishbein
INFORM, Inc.

Publications and Membership

Related Publications

Leasing: A Step Toward Producer Responsibility

Bette K. Fishbein, INFORM, Inc.; Lorraine S. McGarry, Duke University, Nicholas School of the Environment; and Patricia S. Dillon, Tufts University, The Gordon Institute (2000, 75 pp., \$30)

Extended Producer Responsibility: A Materials Policy for the 21st Century

Bette Fishbein; John Ehrenfeld, MIT; and John Young, Materials Efficiency Project (2000, 290 pp., \$30)

Waste at Work: Prevention Strategies for the Bottom Line

John Winter and Anne Marie Alonso (1999, 105 pp., \$30)

Purchasing Strategies to Prevent Waste and Save Money

National Recycling Coalition and INFORM (©1999, 40 pp.)

For more information or to purchase a copy, please contact the National Recycling Coalition at (703) 683-9025 x225, or visit their website.

Getting an "A" at Lunch: Smart Strategies to Reduce Waste in Campus Dining

David Saphire (1998, 26 pp., \$30)

Membership

Individuals provide an important source of support to INFORM. Membership starts at \$35 and includes a one-year subscription to *INFORM Reports*, INFORM's quarterly newsletter.

Additional support entitles the contributor to further benefits, including advance notice of and discounts on new INFORM publications.

All contributions are tax-deductible.

For more information, please call INFORM at (212) 361-2400.

Board of Directors

Dennis J. Krumholz, Chairman

Partner, Riker, Danzig, Scherer, Hyland & Perretti

Michael B. Gerrard, Vice-Chairman

Partner, Arnold & Porter

Debbie Breckenridge

Strachan Donnelley

Director, Humans and Nature Program, The Hastings Center

Soheil Galal

Managing Director, Claredon Partners

Philip J. Landrigan, M.D., M.Sc.

Ethel H. Wise Professor and Chair, Department of Community Medicine, The Mount Sinai Medical Center

Dorcas A. McDonald, Ed.D.

Director, The Learning for Living Institute

Coco Hoguet Neel

Teacher, The Hewitt School

Carol R. Noyes

Ronald M. Ollie

Vice President and Partner, Municipal Business Development, Malcolm Pirnie

Frank T. Thoelen

Joanna D. Underwood

President
INFORM

Bailus Walker Jr., Ph.D., M.P.H.

Professor, Environmental and Occupational Medicine, Department of Community Health and Family Practice, Howard University College of Medicine

Directors Emeriti

C. Howard Hardesty, Jr.

Andrews & Kurth

Kenneth F. Mountcastle, Jr.