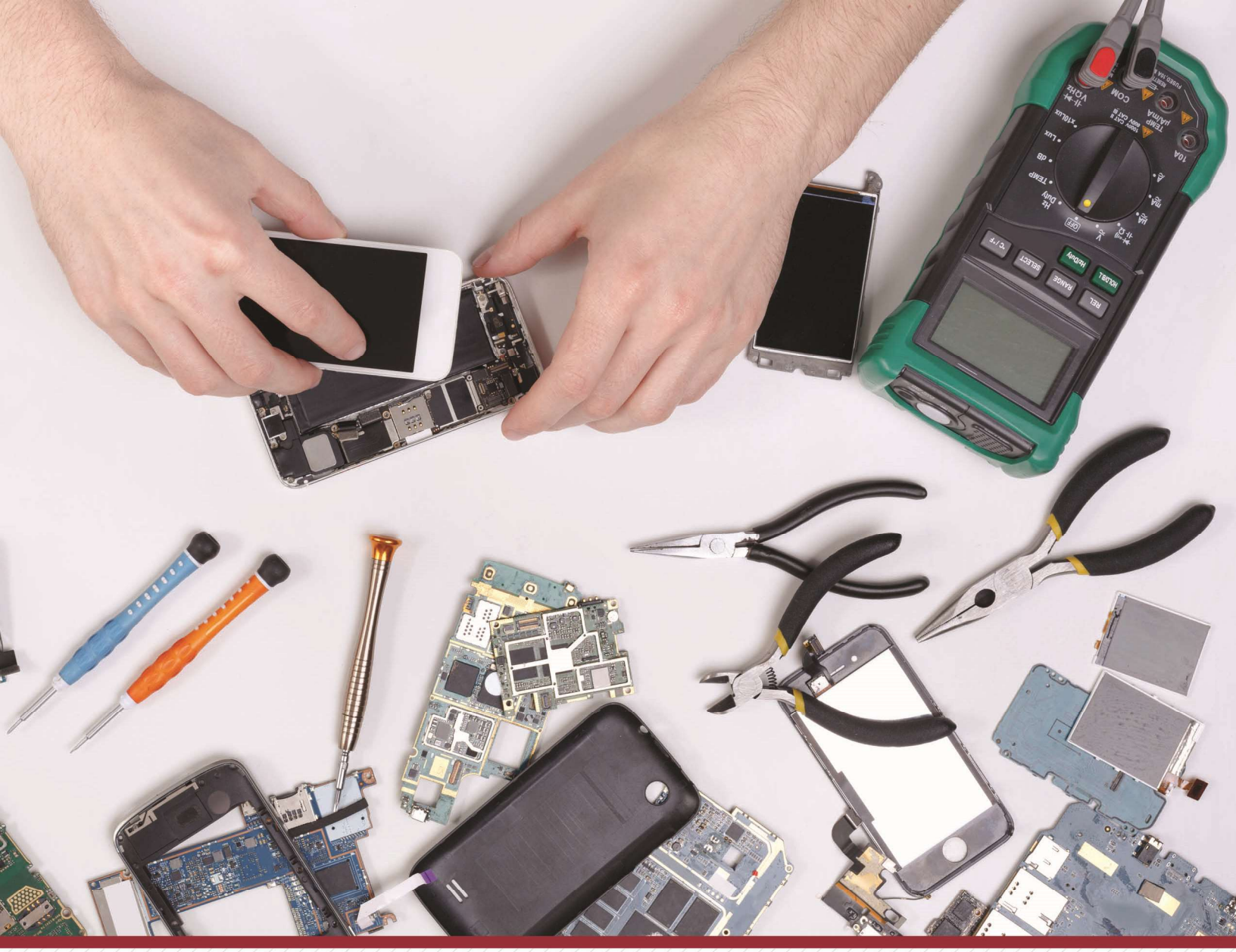

THE FIX IS IN

How our smartphones get fixed, why it's harder than it should be, and why that matters

MARCH 2020

U.S. PIRG Education Fund

Maryland PIRG Foundation

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EXECUTIVE SUMMARY

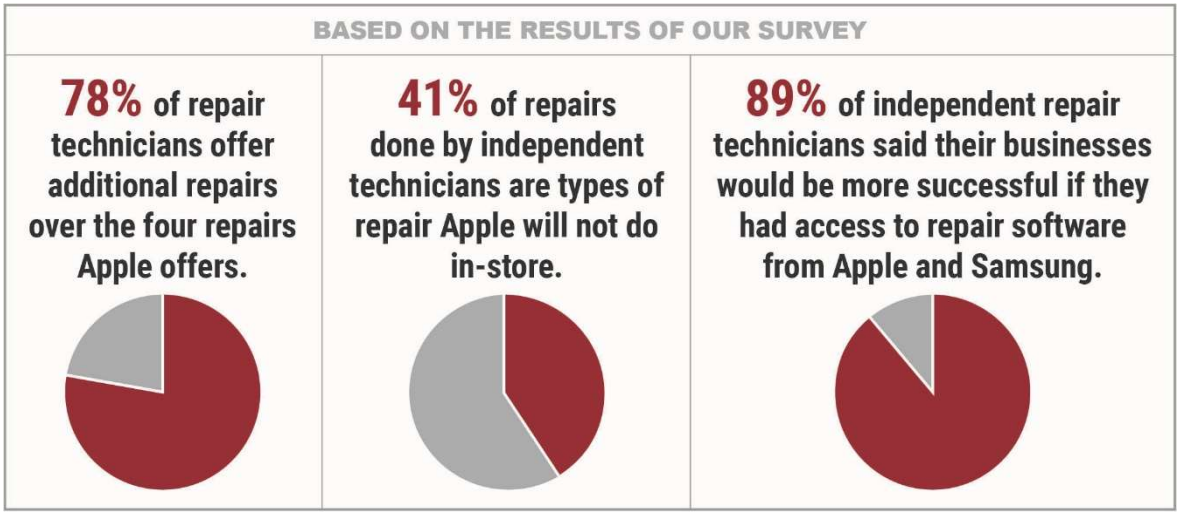
For many of us, our smartphones are a critical part of our daily lives. Juggling our schedules, taking photos of our travels and family events, handling our emails, giving us directions, or connecting us with our friends, clients or colleagues. When our phones break, we want them fixed – fast.

Unfortunately, there are numerous barriers to fixing most smartphones. Apple, Samsung, LG and other smartphone manufacturers don't make diagnostic software, manufacturer original spare parts, or repair documentation available to anyone outside of their authorized repair centers.[i] These authorized repair providers might be a long distance away from many consumers, and they might be severely limited in the repair options that will provide. For example, Apple told Congress last fall that they offer only four varieties of repairs in-store for their phones[ii] – battery, screen, camera and speaker replacements.[iii]

When the companies that make these phones limit repair options, it can put consumers in a bind. Having your choice of repair technician with access to repair tools and spare parts would help keep costs low and expand consumer options.

Working with iFixit.com, U.S. PIRG Education Fund surveyed independent technicians, and 302 phone repair technicians responded. Our survey sought to find out more about what repairs their businesses are doing, and how that compares to the repairs manufacturers make available.

Our survey found that 78% of repair technicians offer additional repairs over the four repairs Apple offers, and overall, 41% of repairs done by independent technicians are types of repair Apple will not do in-store. Additionally, 89% of independent repair technicians said their businesses would be more successful if they had access to repair software from Apple and Samsung.[iv]



When people can't fix their phones – or can't find a repair technician who is willing and has the necessary parts and information to do the job – they must get a new phone. And, in addition to the hit to your pocketbook for a new device, manufacturing a new phone takes a toll on the planet.

Making fewer new phones would make the biggest environmental impact

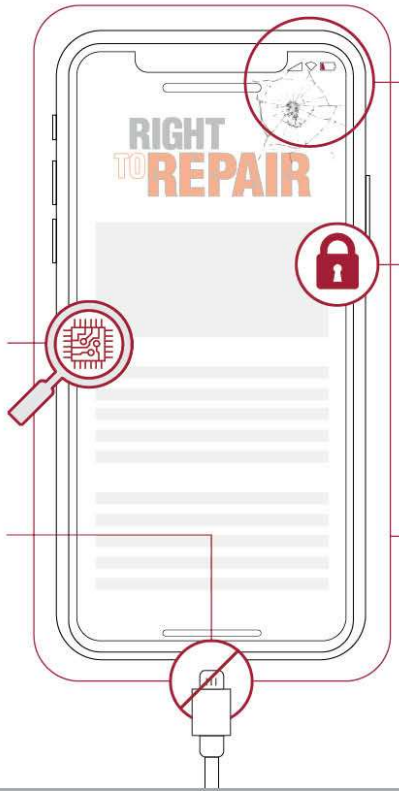
Researchers estimate that 85%[v] of the climate impact of a smartphone comes from manufacturing, the rest for the use phase – and manufacturing and shipping a single phone produces the planet-warming equivalent of 122.7 pounds of carbon dioxide.[vi] A single iPhone 6 takes 295 lbs of raw minerals – 75 lbs of ore ore and 220 lbs water – to produce.[vii]

Given that Americans purchase some 161 million new smartphones each year,[viii] that means our cell phone habit takes some 23.7 million tons of raw material to satisfy – that's like consuming an Empire State Building equivalent in material weight every 6 days. If we held onto our phones 1 year longer on average, the emissions reductions would be equivalent to taking 636,000 cars off the road each year and would reduce manufacturing material demand by 42.5 million pounds per day – which would be like cutting a jumbo-jet's weight in raw material use every 17 minutes.

According to the U.S. EPA, Americans dispose of 416,000 cell phones per day.[ix] Even if these phones were recycled – and indications are that most are not[x] – the clear environmental imperative is in reducing the number of new phones we are forced to produce.

The fix is in

Our survey found that independent repair shops currently offer many repair options that some manufacturers don't make available. Apple and others are making it harder for individuals and independent repair shops to fix our devices.



SCHEMATICS ON LOCKDOWN
When a $0.04 capacitor or other tiny parts break, the repair requires special diagrams so technicians can identify the right tiny connection to solder. Manufacturers refuse to provide repair shops with these schematics.

CLOGGED AND DAMAGED PORTS
Because of frequent plugging and unplugging, charging ports are a common point of failure. Apple and other manufacturers refuse to sell the replacement parts to independent repair shops, and Apple doesn't offer the simple repair of replacing these ports in their stores.

SCREENS AND BATTERIES
Replacing broken screens or worn out batteries are the most common cell phone repairs. Yet manufacturers like Apple and Samsung won't sell spare parts to independent repair shops or provide calibration software.

SOFTWARE LOCKS OUT INDEPENDENT SHOPS
Manufacturers increasingly use software to lock out independent repair, software they will not provide outside their authorized shops. On the latest iPhones, even battery and screen replacement repairs now require special diagnostic software to fully complete, software no manufacturer provides.

REPAIR VS. REPLACE
Manufacturers have an incentive to get us to buy a new device instead of repairing the ones we have. The result? The U.S. EPA estimates that Americans dispose of 416,000 cell phones a day.

INTRODUCTION

Why it's harder to fix our phones than it should be

Phones break for myriad reasons. Some parts are guaranteed to wear out, like the battery, which is a "consumable," and only lasts a certain number of charge cycles.[xi] Other parts like the screen or back glass are more fragile, and more likely to get damaged. The ports and buttons also tend to be a fail point because they are frequently handled. At times, repair is required to address design flaws, such as the "touch disease" issue on iPhone 6 Plus models that results from a chip breaking loose from the logic board when the phone flexes.[xii]

No matter the reason the phone needs repair, technicians typically need a set of things in order to complete the service. They need access to some combination of spare parts or components, technical information or instructions, diagnostic software, tools (including special tools in some cases), and the ability to pair new parts to the rest of the device.

Thirty years ago, most of these aspects were standard. Spare parts were general, and available at electronics stores like Radio Shack, or in part catalogs, and often standardized. Instructions or diagrams were included in the manual, or available from the manufacturer without charge.[xiii] The tools needed were ones you would find in any reasonably stocked toolbox. The device

would display any known errors prominently, and not conceal diagnostic information. There were no software locks against repair or installing new parts.

But modern device-makers design products in such a way that makes independent repair difficult. As products become more reliant on software, it creates new methods to limit repair.

In order to replace the screen on a phone, you need a replacement screen, screens most manufacturers will not sell. In many cases, there are special tools to remove the screen made by the manufacturer, tools which are not sold to independent shops. In the case of Samsung, there is a special machine which slowly heats up the adhesive and opens the phone without damaging the device. Apple devices are held together with pentalobe screws, which need a specialized bit which Apple does not sell.[xiv] [xv] You also need instructions or diagrams to attach that new part, instructions manufacturers do not provide.[xvi] Finally, you may need special software to pair the screen to the phone. Again, this software is not made accessible to anyone outside of the manufacturers control.[xvii]

For some devices and some repairs, people have created workarounds for the manufacturers' barriers. For many phones, you can find certain replacement parts made by third parties, known as aftermarket parts.[xviii] You can buy screwdrivers that open Apple phones, and technicians have developed methods to open Samsung's adhesive without damage.[xix] Also, while manufacturers don't provide instructions, people create public guides, such as those found on iFixit.

Even with the dedication and creativity of the independent repair community, the barriers put in place by manufacturers mean that fewer devices are fixed. Repair shops have to turn away repairs they could handle if they had the proper parts, information and software.

This is especially true for repairs which require special software tools. For example, if you break the home button on your iPhone, you cannot replace it without Apple's software, even if you have an original Apple part (this is not the case with Samsung phones).[xx] Slowly, the number of repairs that require special software tools to complete are growing.[xxi]

Even screen and battery repairs, which, according to our survey was 47% of all repairs, now can require access to proprietary software to complete. With the latest iPhones, even if you replace the battery with another Apple battery, the phone will no longer display battery health information and gives a "Service" warning when you check the battery in settings.[xxii] With screen repairs, the latest iPhone will give popup warning messages to users who have their

screen fixed outside of the Apple's authorized universe, warning against the use of unauthorized parts.[xxiii] Apple stores have software that removes these warnings.[xxiv]

Error messages from iPhone 11 after independent screen repair, courtesy of iFixit.

Software pairing allows manufacturers to eventually design products which are completely locked against independent replacement of any components. Even if there are instructions generated by the public and compatible parts, or parts salvaged from other devices, there will be no way to complete repairs outside of the manufacturers control besides breaking those locks.

While independent shops that focus on repair have an incentive to repair and not replace, the manufacturer has additional incentive to replace devices. This dynamic perhaps explains why independent shops tend to offer a set of repairs the manufacturer will not – in fact, these repairs are a huge part of their total business.

Manufacturers provide limited options

The House Judiciary Subcommittee on Antitrust is investigating Apple, Google, Facebook and Amazon as part of its "Investigation of Competition in Digital Markets."[xxv] One of the specific areas of investigation into Apple is how they treat repair. In the fall of 2019, the Committee requested documents and Rep. David Cicilline (RI) sent a list of questions for Apple to answer.[xxvi]

In November, the House Judiciary Committee posted Apple's response to Rep. Cicilline's questions.[xxvii]

Rep. Cicilline asked "Does Apple limit the repairs it permits AASPs [Apple Authorized Service Providers] to make? If so, please provide a full list of the repairs that AASPs are not permitted to make and explain all the reasons Apple does not permit each type of repair." (Q. 22) [xxviii]

Apple responded by listing the types of repair offered on their devices in the retail stores. For iPhones, that's only 4 types of repair: Display, Battery, Speaker and Camera (A. 22). Additional repairs are offered through a mail-in service, but Apple does not specify which kind of repairs are done through those services (A. 23).

Though Apple didn't elaborate on which repairs are available through mail-in service, there is evidence that even those services are very limited. If you your phone is water-damaged, Apple will not restore the data from that device, but independent technicians can, in most cases, restore that data. [xxix] Doing these repairs often requires "board level" repair – instead of replacing the entire logic board or motherboard of the phone, you have to use a microscope to fix very small components on the board. Board level repair generally requires access to repair documentation.[xxx]

Data recovery services for damaged phones using advanced microsoldering techniques underscore why manufacturer-only repair options fail consumers. Manufacturers do not offer certain repairs, and also take steps which prevent others from offering the service they do not. Consumers could lose critical data, be forced to wait weeks for mail-in repair service (often both), or feel they have no choice but to replace the device.

Consolidated repair could mean far more mail-in service

When you take your broken iPhone to the Apple store, and the problem is not solved one of the four repairs they offer, you are presented with a few options if you want a working phone. You can upgrade to a newer device, swap out your phone with a refurbished device, or wait several weeks while your device is shipped to a repair depot, fixed, and sent back. There is no guarantee that when the device is returned it will still contain your data – contacts, photos or anything else saved on the phone.[xxxi]

In any case, the phone is likely headed to the mail-in repair depot. Your broken phone will either be fixed and returned, fixed to be used as a refurbished phone (and perhaps offered as a replacement for another customer's broken phone), or recycled.[xxxii]

These large mail-in repair centers could even be managed by another company, which subcontracts from the manufacturer.[xxxiii]

While such facilities might be preferable to the manufacturer, whether mail-in repair options are preferable for consumers is another matter. Security and privacy protections in large warehouse-style repair facilities are unknown, and potentially a significant concern. And, of course, waiting several weeks for a working phone is a huge inconvenience.

An example that could point to the downside of repair consolidation can be found in camera repair. By 2012, most camera companies, including Nikon, Sony and Canon had restricted access to parts, with Nikon refusing to sell any parts except to their authorized shops.[xxxiv] At the time, there were 22 Nikon authorized repair shops.[xxxv]

Now, starting March 31, 2020, Nikon will stop supplying any spare parts or service information to the 15 shops currently authorized to fix its cameras – meaning these shops will no longer have access to what they need to fix the cameras. From March 31 on, all Nikon customers will have to ship their broken cameras to one of *two* Nikon repair facilities in the U.S.[xxxvi]

This trend is very concerning. Once choice is limited, and there is no competition for better service, cost reduction can outweigh counter-balancing concerns. For consumer device repair, the result can be much longer downtime, or lower quality repairs.

FINDINGS

In our 302-repair technician survey, conducted online, we sought to learn more about which repairs independent shops offered. We found that independent shops offered a wider variety of repairs and are a critical part of the ecosystem for repair.

Most repair shops offer repairs that Apple doesn't

When Apple wrote to Congress, disclosing that they only offer four types of repair in-store, which didn't include charging ports, we wondered what portion of all cell phone repairs would fall outside of that category.

Ninety six percent of our survey respondents fix screens, 95% fix batteries, 78% fix charging ports, 49% fix water damage and 54% offer board-level repairs to customers (29% in-store, and additional 25% subcontracts out board-level work).

This means that at least 78% of technicians reported their place of businesses offered repairs that fall outside what Apple said they offered. Because Apple does not offer board-level component repair for consumers' devices,[xxxvii] 54% also offered a type of service Apple doesn't offer – board repair.

We also asked technicians to report how many cell phone repairs their business completed per month in a variety of categories. Of the total number of reported cell phone repairs per month, more than 40,000 across the 302 technicians, we learned: Screens were 29% of repairs, Battery replacement was 18%, Speaker and Camera Replacement was another 12%, and 41% of all repairs were not in those four categories.

Screen and battery replacement are a large portion of the repairs, making up 47% of the total. However, an almost equally large portion, 41%, of independent repair store business is offering repairs that at least Apple will not offer in-store. It is important to note that the competition here is not just in *who* is doing the repairs, but *whether or not* the repair is done in the shop *at all*.

Independent technicians see the need for reforms.

The lack of diagnostic software is increasingly a concern. Asked "Would your business be more successful if you had access to Apple or Samsung's repair diagnostic software?" 89% answered

"Yes" and only 2% answered "No." Similarly when asked if they support Right to Repair reforms, 92% of surveyed shops answered "Yes," and only 2% said these reforms were not needed.

CONCLUSION

To preserve consumer choice and reduce waste, independent technicians need to have access to parts, service software, technical information and tools necessary for repairs.

If third-party repair is eliminated, consumers will be significantly harmed. Many of the repairs that are being done by independent shops now would no longer be locally available. Not only are manufacturers restricting competition on repairs they offer, they are also denying access to necessary parts and information for the repairs they choose not to offer.

Empowering more repair would cut costs for consumers and extend the lifespan of our electronics, reducing the material drain and pollution of manufacturing, and reducing the electronic waste heading to landfills.

Regulators and lawmakers should take appropriate steps to ensure that independent repair is protected – such as by supporting Right to Repair legislation.

METHODOLOGY

The survey was conducted online. A link to the survey form was emailed out to iFixit Pro customers. iFixit Pro customers pay a monthly subscription which aids them in more frequent and larger purchase orders from iFixit, which sells electronics tools and spare parts. These customers are based around the country, and some respondents are based internationally. Four responses were eliminated as either being duplicates, or containing non-numerical answers to numerical questions. The data was self-reported by respondents.

The survey collected additional information about the respondents than is covered in this report.

To calculate the impact of longer lifespans on climate and waste, we started with the 161 million new smartphones Americans bought in 2019,[xxxviii] and that Americans use their phones for an average of 24.7 months.[xxxix] We used the estimate of 4600 kg for the average automobile annual CO2 emissions.[xl] The estimate of 55.65 kg of CO2-equivilient emissions from manufacturing

comes from the Restart Project, which averaged 18 mobile phones together across multiple manufacturers.[xli]

We then calculated the reductions in new phones if people increased the average lifespan of their phones and applied those savings to the estimated associated manufacturing waste and climate-harming emissions.

We used an estimate of 365,000 tons for the weight of the Empire State Building,[xlii] and the weight of a jet is 485,300 pounds – based on the Boeing 747.[xliii] We used an estimate that a full grown tree removes 48 pounds of CO2 from the air per year.[xliv]

APPENDIX

If we used our phones one year longer on average, what impact would it make on pollution or raw material use?

	Raw material savings, in tons per year	Raw material savings, in pounds per day	Climate impact, measured in trees per year	Climate impact, measured in the equivalent of taking cars off the road for a year
United States (Combined)	**7,764,900**	**42,547,000**	**134,555,000**	**636,900**
Alabama	114,700	629,000	1,988,000	9,400
Alaska	17,100	94,000	297,000	1,400
Arizona	170,300	933,000	2,952,000	14,000
Arkansas	70,600	387,000	1,224,000	5,800
California	924,600	5,066,000	16,023,000	75,800
Colorado	134,800	738,000	2,335,000	11,100
Connecticut	83,400	457,000	1,446,000	6,800
Delaware	22,800	125,000	395,000	1,900
Florida	502,600	2,754,000	8,709,000	41,200
Georgia	248,500	1,361,000	4,305,000	20,400
Hawaii	33,100	182,000	574,000	2,700
Idaho	41,900	230,000	727,000	3,400
Illinois	296,500	1,625,000	5,139,000	24,300
Indiana	157,500	863,000	2,730,000	12,900
Iowa	73,800	405,000	1,279,000	6,100
Kansas	68,200	374,000	1,181,000	5,600
Kentucky	104,500	573,000	1,812,000	8,600
Louisiana	108,800	596,000	1,885,000	8,900
Maine	31,500	172,000	545,000	2,600
Maryland	141,500	775,000	2,452,000	11,600
Massachusetts	162,600	891,000	2,818,000	13,300
Michigan	233,700	1,281,000	4,050,000	19,200

	Raw material savings, in tons per year	Raw material savings, in pounds per day	Climate impact, measured in trees per year	Climate impact, measured in the equivalent of taking cars off the road for a year
Minnesota	132,000	723,000	2,287,000	10,800
Mississippi	69,600	382,000	1,207,000	5,700
Missouri	143,600	787,000	2,489,000	11,800
Montana	25,000	137,000	433,000	2,100
Nebraska	45,300	248,000	784,000	3,700
Nevada	72,100	395,000	1,249,000	5,900
New Hampshire	31,800	174,000	551,000	2,600
New Jersey	207,900	1,139,000	3,602,000	17,000
New Mexico	49,100	269,000	850,000	4,000
New York	455,200	2,494,000	7,889,000	37,300
North Carolina	245,400	1,345,000	4,253,000	20,100
North Dakota	17,800	98,000	309,000	1,500
Ohio	273,500	1,499,000	4,740,000	22,400
Oklahoma	92,600	507,000	1,605,000	7,600
Oregon	98,700	541,000	1,710,000	8,100
Pennsylvania	299,600	1,642,000	5,191,000	24,600
Rhode Island	24,800	136,000	430,000	2,000
South Carolina	120,500	660,000	2,088,000	9,900
South Dakota	20,700	113,000	359,000	1,700
Tennessee	159,900	876,000	2,771,000	13,100
Texas	678,500	3,718,000	11,758,000	55,700
Utah	75,000	411,000	1,300,000	6,200
Vermont	14,600	80,000	253,000	1,200
Virginia	199,700	1,094,000	3,461,000	16,400
Washington	178,200	976,000	3,088,000	14,600
West Virginia	41,800	229,000	725,000	3,400
Wisconsin	136,300	747,000	2,361,000	11,200
Wyoming	13,500	74,000	235,000	1,100

END NOTES

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