Materials Characterization Paper
In Support of the
Advanced Notice of Proposed Rulemaking –
Identification of Nonhazardous Materials That Are Solid Waste

Scrap Tires

December 17, 2008

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1. Definition of Scrap Tires

Scrap tires are used tires that can no longer be utilized as tires.

2. Annual Quantities of Scrap Tires Generated and Used

(1) **Sectors that generate scrap tires:** Scrap tires are generated from the replacement of tires on passenger and commercial vehicles.

- The majority of scrap tires, 88 percent, come from passenger vehicles and light duty trucks. The remaining 11 percent comes from larger vehicles such as heavy duty trucks and buses (RMA 2006, p. 10).
- Many scrap tires are sent to processors where they are shredded and then sent to end users such as: plants using tire-derived fuel; civil engineering projects (e.g., construction sites for landfills, septic tank leach fields, or roads); and crumb rubber plants where they may be recycled into other products (Virginia Department of Environmental Quality 2008). Other tires are used whole, either in civil engineering or similar projects or as a fuel.

(2) **Quantities of Scrap Tires Generated:** Consumers and industry in the United States generated 299.6 million scrap tires in 2005; this represents approximately 4.9 million tons of tires, assuming an average of 33 pounds per tire (RMA 2006, p.11). Of these tires, less than 15 percent were landfilled. These landfilled tires are “wasted”, with their resource value being lost to society. Exhibit 1 provides a brief overview of the generation and use of scrap tires in 2005. Exhibit 2 provides more detailed information on the uses of scrap tires from 1990 through 2005.

Exhibit 1: Overview of Generation and Use for 2005

Commodity	Annual Quantity Generated	Annual Quantity Used as Fuel	Annual Quantity Land Disposed	Annual Quantity Diverted to Other Uses[1]	Total Quantity Stockpiled as of 2005
Scrap Tires[2]	299.6 million tires 4.4 million tons	155.1 million tires 2.1 million tons 177 facilities	42.42 million tires 0.6 million tons	104.1 million tires 1.5 million tons	188.0 million tires 2.9 million tons

Sources:
Unless otherwise noted, data are from the Rubber Manufacturers Association, *Scrap Tire Markets in the United States,* November 2006, p. 88.

Notes:
1. The quantity diverted to other uses includes 6.9 million exported tires weighing approximately 0.1 million tons.
2. Of the 4.4 million tons of tires generated in 2005, the Rubber Manufacturers Association (RMA) has accounted for how 4.2 million tons were managed. RMA was unable to determine how the remaining 0.2 million tons were managed.

Exhibit 2: Summary of Scrap Tire Uses from 1990 to 2005

	Millions of Tires Used							
Scrap Tire Use	**1990**	**1992**	**1994**	**1996**	**1998**	**2001**	**2003**	**2005**
Tires Used for Tire Derived Fuel	24.5	57.0	101.0	115.0	114.0	115.0	129.7	155.1
Cement Kilns	6.0	7.0	37.0	34.0	38.0	53.0	53.0	58.0
Pulp/paper Mills	13.0	14.0	27.0	26.0	20.0	19.0	26.0	39.0
Industrial Boilers	0.0	6.0	10.0	16.0	15.0	11.0	17.0	21.0
Utility Boilers	1.0	15.0	12.0	23.0	25.0	18.0	23.7	27.0
Non-Fuel Uses	0.0	11.0	37.5	49.5	63.5	103.0	103.6	104.0
Civil Engineering	N/A	5.0	9.0	10.0	20.0	40.0	56.4	49.2
Ground Rubber	0.0	5.0	1.5	7.5	7.0	21.0	18.2	30.1
Export	0.0	0.0	12.5	15.0	15.0	15.0	9	6.9
Cut/Punched/Stamped	N/A	N/A	8.0	8.0	8.0	8.0	6.5	6.1
Miscellaneous/Agriculture	N/A	1.0	3.5	4.0	5.5	7.0	3.0	3.0
Electric Arc Furnaces	N/A	N/A	N/A	N/A	N/A	N/A	0.5	1.3
Rubber Modified Asphalt	N/A	N/A	3.0	5.0	8.0	12.0	10.0	7.4
Scrap Tires in Stockpiles	1000.0	1,000.0	800.0	500.0	400.0	300.0	275.0	188.0

Sources:
Unless otherwise noted, data is from the Rubber Manufacturers Association, *Scrap Tire Markets in the United States,* November 2006, p. 86.

(3) **Trends in Generation:**

- Scrap tire generation increased by 25 percent from 1990 to 2005, while the amount reused or recycled increased from 11 percent in 1990 to 87 percent in 2005. This reflects a major accomplishment in effective materials management.
- During this same period, the number of tires in stockpiles declined by more than 80 percent, from 1 billion to 188 million (RMA 2006, p.86).
- The use of tires for fuel has increased from 24.5 million tires in 1990 to 155.1 million tires in 2005. The Rubber Manufacturers Association (RMA) suggests that the use of tires as a fuel source will likely continue and may increase as the cost of conventional fossil fuels increases (RMA 2006, p.20).
- States have contributed to the increased use of scrap tires as a fuel and for other purposes by regulating scrap tires and by working with the public and private sectors to improve the management of scrap tires to minimize landfilling, stockpiling, and illegal dumping (EPA 2007). Exhibit 3 demonstrates that stockpiles have been depleted despite increased generation, while Exhibit 4 illustrates the increasing rate of reuse/recycling of scrap tires.

Exhibit 3: Changes in Scrap Tire Generation and Stockpile Depletion

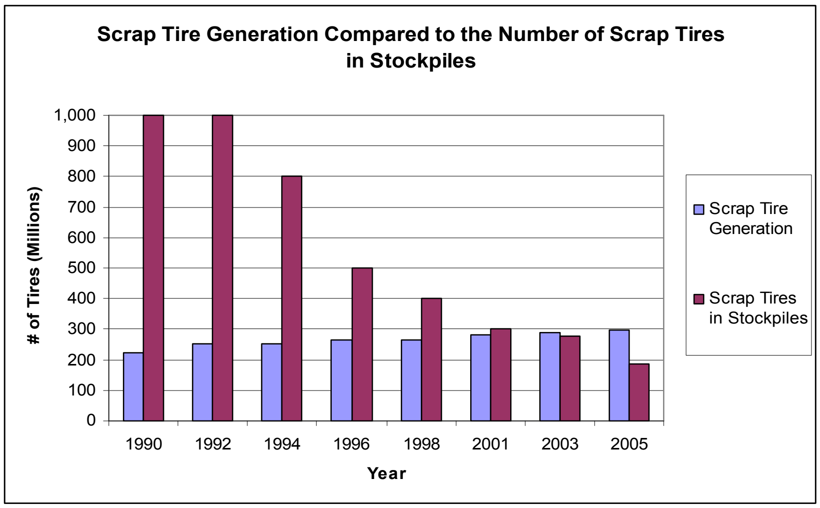
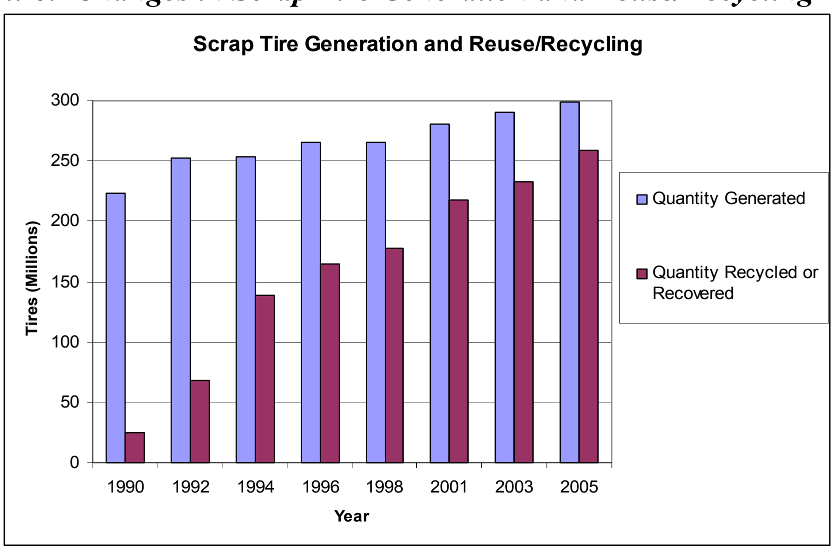


Exhibit 4: Changes in Scrap Tire Generation and Reuse/Recycling



3. *Uses of Scrap Tires*

(1) **Combustion Uses of Scrap Tires:**
A major use of scrap tires is as fuel, either in whole form or as tire-derived fuel (TDF). Whole tires are frequently used as fuel in cement kilns, where their steel provides an additional benefit, as kiln operations require iron. Otherwise, use of whole tires is limited by whether they fit into combustion units (EPA 2008b). TDF is defined by ASTM as scrap tires that have been shredded and processed into rubber chips according to product standards. The use of TDF in combustion units is typically limited to blends of 10 – 30 percent of total energy input due to the high rates of heat release and the low moisture content of TDF. Thus, TDF is often used as a supplementary fuel in combustors to complement other fuel sources such as coal and biomass (ASTM 2006, p.4).

- Cement manufacturers account for 40 percent of users of tires as fuel in the United States. Electric utilities were the second largest users (33 percent) and paper manufacturers were the third largest users (20 percent). These three industries account for more than 90 percent of users of tires as fuel in the United States (RMA 2006, pp. 89-90)
- As of 2005, there were 121 facilities using tire-derived fuel in the U.S. (RMA 2006, pp. 89-90). Exhibit 5 presents the 3-digit NAICS codes for these facilities. Appendix 1 includes basic identifying information for each facility in the U.S. known to be utilizing TDF.
- The use of scrap tires as fuel accounts for nearly 60 percent of the beneficial use of scrap tires, as indicated in Exhibit 6.
- As shown in Exhibit 7, the use of tires as fuel has increased significantly since 1990. RMA indicates that the increased use of tires as fuel is likely due to increased energy prices for conventional fossil fuels and improvements in tire processing (RMA 2006, p.17).

Exhibit 5: NAICS Codes for Facilities Using Tire-Derived Fuel

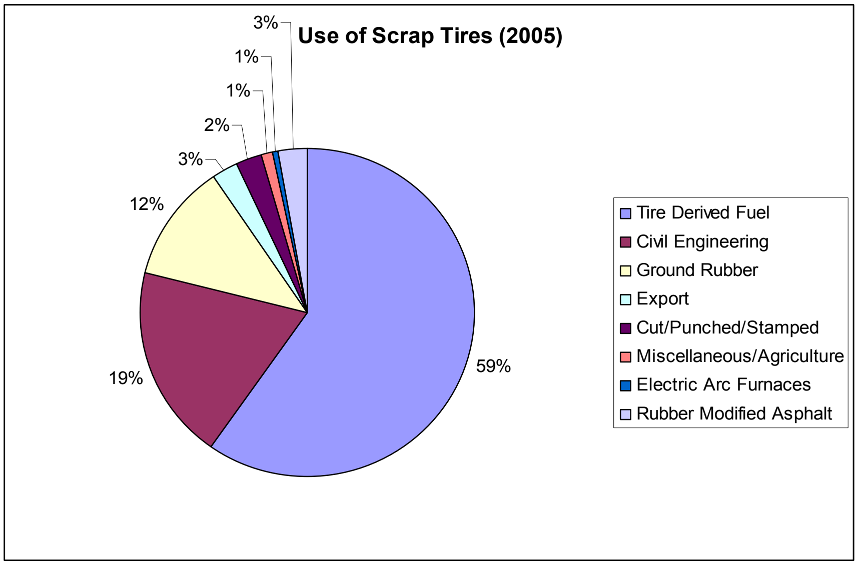
NAICS	NAICS Title	Count
327	Nonmetallic Mineral Product Manufacturing	49
221	Utilities	40
322	Paper Manufacturing	24
331	Primary Metal Manufacturing	3
611	Educational Services	2
311	Food Manufacturing	1
928	National Security and International Affairs	1
562	Waste Management and Remediation Services	1
Source: U.S. Census Bureau 2007		

(2) **Non-Combustion Scrap Tire Uses:** Although energy recovery is the most common use of scrap tires, there are many non-fuel uses for scrap tires including the following:

- Agriculture/Miscellaneous (i.e., erosion control) (RMA 2006, p.51)
- Civil Engineering (i.e., construction of landfills and roads) (RMA 2006, pp. 33,36)

- Cut/Punched/Stamped into other products (e.g., floor mats) (RMA 2006, p.43)
- Electric Arc Furnaces (i.e., these units combust tires to utilize energy value *and* to incorporate carbon and steel into new steel products) (RMA 2006, p. 47)
- Ground Rubber (e.g, synthetic sports field turf) (RMA 2006, p. 39)
- Rubber Modified Asphalt (RMA 2006, p.44)

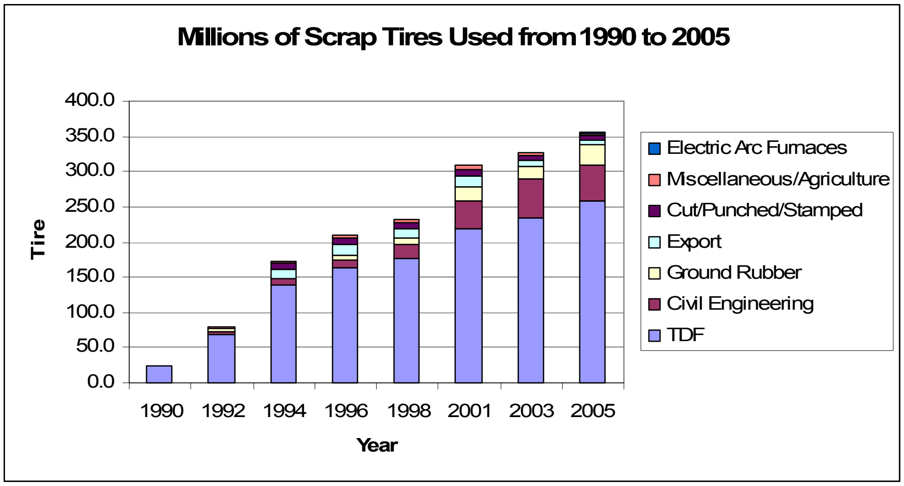
Exhibit 6: Use of Scrap Tires in 2005



(Source: RMA 2006, p.86)

- Similar to the increased use of scrap tires as a fuel source, the beneficial use of scrap tires in non-combustion applications has increased significantly between 1990 and 2001. Since 2001, however, the amount of scrap tires used for non-combustion applications has been fairly constant, whereas the amount used as fuel has continued to increase. This trend reflects the high fuel value of tires. The increased acceptance of tires as a legitimate fuel led to success in reduction of tire piles. With the increase in fuel prices since 2001, beneficial use of tires as fuel has become a more attractive management option than other beneficial use applications.

Exhibit 7: Trends in the use of Scrap Tires from 1990 – 2005



(RMA 2006, pp 17-18)

(3) **Quantities of Scrap Tires Landfilled:** The number of tires landfilled has slowly declined as the use of TDF and other applications for tires has increased. This trend reflects an important environmental accomplishment. Despite efforts to minimize the number of tires sent to landfills, tires are still landfilled because of the high cost of hauling tires to a processing facility in some areas, or if they are in too poor of condition to be suitable for beneficial use applications. This reflects a significant waste of resources. In general, the placement of whole tires in above-ground landfills is discouraged due to their large size, flammability, and potential to harbor mosquitoes. As an alternative, scrap tires may be placed in an underground monofill (RMA 2006, p.53). While EPA considers monofill disposal preferable to traditional above-ground tire piles, these are also a clear waste of valuable resources (EPA 2007).

(4) **Quantities of Scrap Tires Stockpiled/Stored:** Stockpiles of tires have been steadily decreasing as a result of state efforts to eliminate "tire piles." States are typically responsible for regulating scrap tires, and each state, with the exceptions of Alaska and Delaware, has developed laws and requirements to address scrap tire concerns. While some states focus mostly on the management of scrap tires as they are generated, others have also developed programs to address existing tire stockpiles (EPA 2007). The majority of current stockpiles are located in seven states: Alabama, Colorado, Connecticut, Michigan, New York, Pennsylvania, and Texas (RMA 2006, p.7). As indicated in Exhibit 3, the number of tires in stockpiles has fallen by more than 80 percent since 1990. Most states, like EPA, encourage the use of tires as fuel. Some states have formally determined, under state law, that combustion of tires is not related to waste management, but is actually a beneficial use of resources.

4. Management and Combustion Processes for Tire-Derived Fuel

(1) **Types of Units Combusting Tires as Fuel:** Tires are combusted as fuel in a variety of applications, including in boilers and kilns (RMA 2006, p.86). They can be used to supplement and/or replace a wide range of fuels including coal, coke, fuel oil, natural gas, and wood. Although many combustion units were not designed to burn tires, many are able to use tires as a supplement to conventional fuels (ASTM 2006, pp. 1 and 4).

(2) **Supply/Processing Chain for Tires Used as Fuel**: While scrap tires are generated from many different sources, they are generally consolidated at key collection points (e.g., tire retailers, automotive repair shops, and fleets) through well-established channels before being shipped to processing facilities and end users. Exhibit 8 summarizes the processing chain for scrap tires used as TDF. Scrap tires are also recovered from historical tire piles.

Exhibit 8: Typical Process for Recovering Tires for Tire-Derived Fuel

Scrap tires are removed from passenger vehicles and trucks.

↓

Tires that are no longer usable are collected at retailers, fleets, etc. until they are ready for transport.

↓

Tires are transported to processing facilities.

↓

Tires are chipped/shredded.[1]

↓

Sent to TDF facility for combustion.

(Texas Commission on Environmental Quality 2008)

1. In some cases, combustion devices accept whole tires, which can provide environmental advantages over chipped tires (e.g., energy savings from avoided chipping and improvement of combustion characteristics).

(3) **Processing Scrap Tires for Fuel Applications:**
Scrap tires are often processed through two physical processing steps: chipping/ shredding and metal removal. Shredded tires used as fuel consist of chipped tires ranging in size from 1 to 4 inches; the amount of metal in this material varies depending on how much the tires have been processed. This processing step is beneficial for many combustion units because it minimizes the metals content of the tires and improves heating efficiency. The price of TDF increases with the removal of metals (ASTM 2006, p.5). However, some units such as cement kilns do not require the removal of wire because their processes are hot enough to oxidize the

wire. Also, the metals provide a positive value in the process as a substitute for raw materials, and considerable energy is saved by not chipping tires. Furthermore, some argue that the combustion characteristics of tires (and the emissions produced) are improved when combusted whole in certain combustion devices (e.g., cement kilns).

Because the specifications for TDF are somewhat user specific, the ASTM has not issued recommended specifications for TDF or the processing of scrap tires for use as TDF.

While newly generated scrap tires can typically be processed for TDF applications, many tires in tire piles are in such poor condition that they cannot be processed and used as TDF. The only notable potential use of these tires is in cement kilns, and otherwise, the only viable management option is landfill or monofill disposal (RMA 2006, pp. 22, 53).

(4) **Recognition of Value in Using this Alternate Fuel – by Regional, State, and Academic Parties:**
The Resource Conservation Challenge (RCC) Scrap Tire Workgroup[1] has two goals related to scrap tires: (1) to manage 85 percent of scrap tires through reuse, recycling, and energy recovery and (2) to reduce the number of stockpiled tires by 55 percent from 2001 to 2008. To help meet these goals, the RCC workgroup has developed subcommittees to target different applications in order to make progress, one of which is the Tire-Derived Fuel Subcommittee, which is striving to support the expanded and appropriate use of scrap tires as a supplemental energy resource in properly permitted industrial facilities (RMA 2006, p.76).

(5) **State Status of Scrap Tire Used as Fuel:**
According to state responses to a 2006 survey by the Association of State and Territorial Solid Waste Management Officials (ASTSWMO), the following states have approved the use of scrap tires as fuel on at least one occasion: Maryland, Pennsylvania, Kentucky, Maine, and North Dakota. This use does not appear to have pre-approved status, however, suggesting that a case-by-case approval process for designation of beneficial use is in place in these states (ASTSWMO 2007, p.B-38-39). In addition, the following states have given pre-approved beneficial use determinations to the use of scrap tires as fuel: Indiana, Iowa, North Carolina, and Virginia.

[1] The Scrap Tire Workgroup contributes to the overall goals of Resource Conservation Challenge (RCC), a multi faceted initiative implemented by USEPA with three overarching goals: 1. to prevent pollution and promote recycling and reuse of materials; 2. to reduce the use of toxic chemicals; and 3. to conserve energy and materials. The Scrap Tire Workgroup of the RCC works on various issues related to scrap tire management and markets. The workgroup consists of over 50 representatives from various state environmental agencies, industry, trade groups, EPA and academia with expertise in scrap tire management, market development, and application technologies.

5. *Scrap Tire and TDF Composition and Impacts*

(1) **Composition of Tires Used as Fuel:**

Tires have a high energy content ranging from 12,000 – 16,000 Btus per pound. This is higher than many conventional fossil fuels (e.g., coal). Tires that have been processed to remove metal will have higher heating values per pound than tires that have not been processed to minimize metals. However, cement kilns report that the savings are greater overall when energy is not expended to shred tires. Also, the metal in tires is an important raw material in cement manufacturing.

The Btu Values of tires and a number of other fuels are as follows:

- Tires: 12,000 – 16,000 Btu/pound (North Carolina Division of Pollution Prevention and Environmental Assistance (NCDPPEA))
- Coal: 11,000 - 13,000 Btu/pound (NCDPPEA and EIA 2005, Table A5)
- Wood 5,000 Btu/pound (NCDPPEA)
- Gas 21,000 – 24,000 Btu/pound (ASTM 2006, p.5)
- Oil 17,000 – 19,000 Btu/pound (ASTM 2006, p.5)

Exhibit 9 summarizes the metals content of tire-derived fuel and two fuels that it may displace: fuel oil and coal.

Exhibit 9: Metals Content of TDF, Fuel Oil, and Coal

Metals Concentrations (Parts Per Million by Weight)

	TDF	Fuel Oil	Coal
Barium	Non-detect	0.3	200
Cadmium	6	0.5	0.5
Chromium	97	0.5	20
Lead	65	-	40
Manganese	<100	-	70
Zinc	15,200	-	100

Sources:
TDF estimates and the zinc estimate for coal are from EPA 1998, p. 1-5
Fuel oil and coal (excluding zinc) are from Gray 2004, p. 11

(2) **Impact Information**

- ***Cost Savings of Beneficial Use Applications***: The net cost savings associated with the beneficial use of scrap tires (i.e., the cost savings realized less the costs associated with beneficial use) are a function of (1) avoided disposal costs, (2) fuel (or other input) savings associated with the beneficial use of this material, and (3) processing (e.g., shredding) and other costs associated with beneficial use. Exhibit 10 summarizes readily available information on these variables. Based on this information, it is not possible to generate a single estimate of the net cost savings or benefits associated with the beneficial use of scrap tires. As suggested by the exhibit, avoided disposal costs depend on the location of disposal. In addition, information is not readily available on the costs of processing tires for beneficial use applications.

Exhibit 10: Summary Economic Savings and Costs of Scrap Tire Beneficial Use

Savings
Avoided Disposal Costs Tip fees associated with landfill disposal vary by location and depend on the size of the tire. Example tip fees reported by local waste management authorities in California, Pennsylvania, and Virginia are as follows: California: $68 per ton (California Integrated Waste Management Board) Centre County, Pennsylvania: $66 per ton (Centre County Solid Waste Authority, 2003) Page County, Virginia: $155 per ton (Page County, 2008)
Fuel or Material Cost Savings The fuel and material costs savings associated with beneficial use depend on the value of the fuel or input for which scrap tires serve as a substitute. The average cost of various fuels for which scrap tires are a substitute are as follows (2007 prices unless otherwise noted):[1] • Natural Gas (Industrial): $7.35 / MMBtu (EIA 2008a, Table 20) • No. 2 Distillate (Industrial): $16.80 / MMBtu (EIA 2008b, Table 36) • Residual Fuel Oil Average: $9.19 / MMBtu (EIA 2008b, Table 38) • Coal – Average Delivered Price in 2006: $2.23 / MMBtu (EIA 2007, Table ES1)
Costs
Processing and Other Costs of Beneficial Use Information on the costs of scrap tire beneficial use applications is not readily available.
<u>Notes:</u> 1. To express these values as dollars per MMBtu, the following thermal conversion factors were used: 1,031 Btu per 1,000 cubic foot of natural gas, 138,690 Btu per gallon of Number 2 distillate, 149,690 Btu per gallon of residual fuel oil, and 22,473,000 Btu per short ton of coal (EIA 2005, Tables A1, A4, and A5).

- ***Criteria Pollutants and Hazardous Air Pollutants:*** Although numerous studies have been conducted on the criteria pollutant and hazardous air pollutant (HAP) emissions associated with tire-derived fuel, most of these studies examine fuels that are a combination of scrap tires and conventional fuels. Therefore, these studies do not isolate the criteria pollutant or HAP emissions associated with scrap tires alone.

  Although existing studies do not include sufficient data to isolate the emissions associated with scrap tires alone, it is possible to reach a few general conclusions based on the results of these studies. For example, emissions test data compiled by EPA in 1997 suggest that substituting scrap tires for coal in electric utility boilers may lead to reductions in NO_x and particulate matter emissions but show no clear pattern for SO_x emissions (EPA 1997, p. 35). The same study also examined the emissions impacts associated with tire combustion at several other types of facilities (e.g., pulp and paper mills, cement kilns, and industrial boilers) that use a variety of different fuels. In addition, a 2004 paper by Gray includes information on the emissions impact of TDF at six sample facilities. Based on this paper and the 1997 EPA study, Exhibit 11 indicates whether the use of tires as a fuel at each facility type may lead to a reduction or an increase in emissions. The available studies on emissions related to tires as fuel examine only a limited number of emissions sources, and it is unclear whether these sources are representative of the combustion units that may use tires. Note that at well-controlled facilities, emissions will not change significantly when tires are used. We further note that variation in emissions could be attributable to factors other than the use of tires itself (such as variations in air pollution control device efficiency).

Exhibit 11: Emissions Impact of Using Tires as a Substitute for Conventional Fuels, by pollutant and combustor type

	NO_x	**PM**	**SO_2**	**Zinc**
Utility boilers	Reduction	Reduction	Data inconclusive	Data inconclusive
Industrial boilers	Reduction	Reduction	Data inconclusive	Increase
Pulp & paper mills	Reduction or similar	Increase	Increase	Increase
Cement kilns	Data inconclusive	Reduction	Reduction	Data inconclusive

Sources:
The information presented in this exhibit is based on emissions data in EPA 1997 and Gray 2004.

Notes:
1. "Reduction" indicates that emissions test data suggest that the use of TDF as a fuel will reduce emissions. "Increase" indicates that emissions may increase, and "similar" indicates that emissions are unlikely to change. "Data inconclusive" indicates that the available emissions data show no clear pattern with respect to the emission impact of using TDF as a substitute for conventional fuel.

- ***Upstream Emissions Impacts:*** Use of tires as a replacement for fossil fuels may eliminate the environmental impacts associated with extraction and processing of the traditional fuels. Exhibit 12 lists the quantities of cradle-to-gate emissions for these fuels based on typical processes in the United States in the late 1990s. The generation of scrap tires generally creates minimal emissions. Of course, there are impacts associated with the shredding of scrap tires into TDF, and these are not accounted for in Exhibit 12.
- ***Other Impacts:*** In addition to the impacts outlined above, the beneficial use of scrap tires limits, and in some cases prevents, the growth of scrap tire stockpiles. This could result in improvements to human health and the environment because such stockpiles provide habitat for disease vectors (such as mosquitoes and rodents), and because they can catch fire, creating large amounts of toxic smoke and hazardous liquids that can contaminate air, water and soils.

Exhibit 12: Emissions from Extraction and Processing of Traditional Fuels

Pollutant	Coal	Distillate Fuel Oil	Residual Fuel Oil	Wood	Natural Gas
	Lb./MMBtu				
Criteria Pollutants					
PM2.5	-	-	-	-	-
PM10	-	-	-	-	-
PM, unspecified	0.246	0.012	0.012	$6.67x10^{-4}$	0.004
NOx	0.022	0.061	0.062	0.08	0.117
VOCs	0.008	0.361	0.365	-	0.515
SOx	0.022	0.186	0.187	0.003	1.913
CO	0.017	0.046	0.046	0.022	0.223
Pb	$2.60x10^{-7}$	$1.01x10^{-6}$	$1.00x10^{-6}$	-	$2.72x10^{-7}$
Hg	$8.17x10^{-8}$	$1.87x10^{-7}$	$1.87x10^{-7}$	-	$7.18x10^{-8}$

Source:
Franklin Associates 1998.

Note:
"-" signifies data not available; may equal zero.

The emission information presented in this table is derived from Life Cycle Inventory (LCI) data, as compiled by Franklin Associates. LCI data identifies and quantifies resource inputs, energy requirements, and releases to the air, water, and land for each step in the manufacture of a product or process, from the extraction of the raw materials to ultimate disposal. The LCI can be used to identify those system components or life cycle steps that are the main contributors to environmental burdens such as energy use, solid waste, and atmospheric and waterborne emissions. Uncertainty in an LCI is due to the cumulative effects of input uncertainties and data variability.

There are several life cycle inventory databases available in the U.S. and Europe. For this paper, we applied the most readily available LCI database that was most consistent with the materials and uses examined. These LCI data rely on system boundaries as defined by Franklin Associates, as described in the documentation for this database, available at: http://www.pre.nl/download/manuals/DatabaseManualFranklinUS98.pdf.

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Appendix 1: Summary of Facilities Using Tires as Fuel[2]

TDF User	City	State	Type of Facility	NAICS
6 unspecified sites	Across state	FL	Waste-to-Energy	221
AES Hawaii	Oahu	HI	Industrial Boiler	221
Akron Thermal, LLP	Akron	OH	Utility Boiler	221
Allegany Power	Parkersburg	WV	Utility Boiler	221
Allen Steam Plant	Memphis	TN	Utility Boiler	221
Alliant Energy	Cassville	WI	Utility Boiler	221
Alliant Energy Edgewater Generating Station	Sheboygan	WI	Utility Boiler	221
Ameren/UE, Inc.	Portage Des Sioux	MO	Utility Boiler	221
American Resource Recovery Corp.	Monroe	MI	Industrial Boiler	221
Aquila, Inc.	St. Joseph	MO	Utility Boiler	221
Aquila/Sibley Generating Station	Kansas City	MO	Utility Boiler	221
Black River Electric	Fort Drum	NY	Utility Boiler	221
Cogentrix	Roxboro	NC	Industrial Boiler	221
Cogentrix	Southport	NC	Industrial Boiler	221
Cogentrix	Lumberton	NC	Industrial Boiler	221
Cogentrix	Richmond	VA	Industrial Boiler	221
East Kentucky Power	Maysville	KY	Utility Boiler	221
Empire District Electric Co. Asbury Power Plant	Joplin	MO	Utility Boiler	221
Exeter Energy	Sterling	CT	Dedicated Tire-to-energy Facility	221
Grayling Generating Station	Grayling	MI	Industrial Boiler	221
Hillman Power	Hillman	MI	Utility Boiler	221
Illinois Power	Baldwin	IL	Utility Boiler	221
Mt. Poso Cogeneration	Bakersfield	CA	Utility Boiler	221
Owensboro Municipal Utilities	Owensboro	KY	Utility Boiler	221
Port Stockton District Energy Facility	Stockton	CA	Industrial Boiler	221
Ridge Generating Station	Auburndale	FL	Utility Boiler	221
Stockton Co-Generation	Stockton	CA	Industrial Boiler	221
Tire Energy Corp (TEC)	Martinsville	VA	Industrial Boiler	221
Tondu Energy	Filer City	MI	Utility Boiler	221
Trigen Biopower	Hodges	SC	Industrial Boiler	221
Viking Energy	McBain	MI	Utility Boiler	221
Viking Energy	Lincoln	MI	Utility Boiler	221
WPS Empire State	Niagra Falls	NY	Industrial Boiler	221
Wyandotte Power	Wyandotte	MI	Utility Boiler	221
Xcel Energy Bayfront Plant	Ashland	WI	Utility Boiler	221
Archer Daniels Midland	Decatur	IL	Industrial Boiler	311
Boise	Deridder	LA	Pulp and Paper Mill	322

[2] This list of facilities was comprised from the Rubber Manufacturers Association list of users of tires as fuel. EPA has published a more recent list that includes 48 cement kilns but we used the RMA list as it is consistent with the combustion data used throughout this paper (EPA 2008c).

TDF User	City	State	Type of Facility	NAICS
Bowater	Catawba	SC	Pulp and Paper Mill	322
Bowater	Calhoun	TN	Pulp and Paper Mill	322
Cascade	Boise	ID	Pulp and Paper Mill	322
Domtar, Inc.	Ashdown	AR	Pulp and Paper Mill	322
Georgia Pacific	Crossett	AR	Pulp and Paper Mill	322
Georgia Pacific	Brunswick	GA	Pulp and Paper Mill	322
Georgia Pacific	Woodland	ME	Pulp and Paper Mill	322
Inland-Rome	Rome	GA	Pulp and Paper Mill	322
International Paper Corporation	Courtland	AL	Pulp and Paper Mill	322
International Paper Corporation	Pine Bluff	AR	Pulp and Paper Mill	322
International Paper Corporation	Mansfield	LA	Pulp and Paper Mill	322
International Paper Corporation	Bastrop	LA	Pulp and Paper Mill	322
International Paper Corporation	Bucksport	ME	Pulp and Paper Mill	322
International Paper Corporation	Eastover	SC	Pulp and Paper Mill	322
International Paper Corporation	Georgetown	SC	Pulp and Paper Mill	322
Interstate Paper	Riceboro	GA	Pulp and Paper Mill	322
NewPage Corporation	Wickliffe	KY	Pulp and Paper Mill	322
NewPage Corporation	Rumford	ME	Pulp and Paper Mill	322
NewPage Corporation	Chillicothe	OH	Pulp and Paper Mill	322
Smurfit-Stone Container Enterprise	Stevenson	AL	Pulp and Paper Mill	322
Sonoco Products Company	Hartsville	SC	Pulp and Paper Mill	322
SP Newsprint Co.	Dublin	GA	Pulp and Paper Mill	322
Thilmany Papers	De Pere	WI	Pulp and Paper Mill	322
Allentown Cement	Blandon	PA	Cement Kiln	327
Ash Grove Cement Co.	Foreman	AR	Cement Kiln	327
Ash Grove Cement Co.	Inkom	ID	Cement Kiln	327
Ash Grove Cement Co.	Chanute	KS	Cement Kiln	327
Ash Grove Cement Co.	Durkee	OR	Cement Kiln	327
Ash Grove Cement Co.	Midlothian	TX	Cement Kiln	327
Ash Grove Cement Co.	Leamington	UT	Cement Kiln	327
Ash Grove Cement Co.	Seattle	WA	Cement Kiln	327
Buzzi Unicem USA	Oglesby	IL	Cement Kiln	327
Buzzi Unicem USA	Cape Giradeau	MO	Cement Kiln	327
California Portland Cement	Ontario	CA	Cement Kiln	327
Capital Cement	San Antonio	TX	Cement Kiln	327
CEMEX	Demopolis	AL	Cement Kiln	327
CEMEX	Victorville	CA	Cement Kiln	327
CEMEX	Brooksville	FL	Cement Kiln	327
CEMEX	Clinchfield	GA	Cement Kiln	327
CEMEX	Knoxville	TN	Cement Kiln	327
CEMEX	New Braunfels	TX	Cement Kiln	327
CEMEX/Downtown Cement	Odessa	TX	Cement Kiln	327
Chemical Lime Company	Grantsville	UT	Lime Kiln	327
Essroc Cement Corp.	Joppa	MD	Cement Kiln	327
Essroc Cement Corp.	not specified	MD	Lime Kiln	327
Essroc Cement Corp.	Pryor	OK	Cement Kiln	327
Essroc Cement Corp.	Meadville	PA	Cement Kiln	327

TDF User	City	State	Type of Facility	NAICS
Florida Rock Industries	Gainesville	FL	Cement Kiln	327
Holcim Inc.	Theodore	AL	Cement Kiln	327
Holcim Inc.	Florence	CO	Cement Kiln	327
Holcim Inc.	Mason City	IA	Cement Kiln	327
Holcim Inc.	Dundee	MI	Cement Kiln	327
Holcim Inc.	Clarksville	MO	Cement Kiln	327
Holcim Inc.	Ada	OK	Cement Kiln	327
Holcim Inc.	Midlothian	TX	Cement Kiln	327
Holcim Inc.	Morgan	UT	Cement Kiln	327
Lafarge North America	Calera	AL	Cement Kiln	327
Lafarge North America	Grand Chain	IL	Cement Kiln	327
Lafarge North America	Tulsa	OK	Cement Kiln	327
Lafarge North America	Whitehall	PA	Cement Kiln	327
Lafarge North America	Harlyeville	SC	Cement Kiln	327
Lehigh Cement Company	Leeds	AL	Cement Kiln	327
Lehigh Southwest	Redding	CA	Cement Kiln	327
Lone Star Cement	Mary Neal	TX	Cement Kiln	327
Mitsubishi Cement Corp.	Lucerne Valley	CA	Cement Kiln	327
Monarch Cement Company	Humboldt	KS	Cement Kiln	327
National Cement	Ragland	AL	Cement Kiln	327
National Cement Co. of California	Lebec	CA	Cement Kiln	327
Rinker Materials Corporation	Brooksville	FL	Cement Kiln	327
St. Lawrence Cement Co.	Hagerstown	MD	Cement Kiln	327
Texas Industries Cement	New Braunfels	TX	Cement Kiln	327
Texas Lehigh Cement	Buda	TX	Cement Kiln	327
Gerdau Ameristeel	Jackson	TN	Electric Arc Furnace	331
Nucor Steel	Jackson	MS	Electric Arc Furnace	331
Nucor Steel	Auburn	NY	Electric Arc Furnace	331
Southeastern Public Service Authority	Portsmouth	VA	Industrial Boiler	562
University of Missouri-Columbia	Columbia	MO	Industrial Boiler	611
University of Wisconsin Charter Street Plant	Madison	WI	Industrial Boiler	611
Fort Detrick	Fredrick	MD	Industrial Boiler	928

(RMA 2006, pp. 89-90 and U.S. Census Bureau 2007)