Sustainable Energy Recovery in the U.S. Cement Sector

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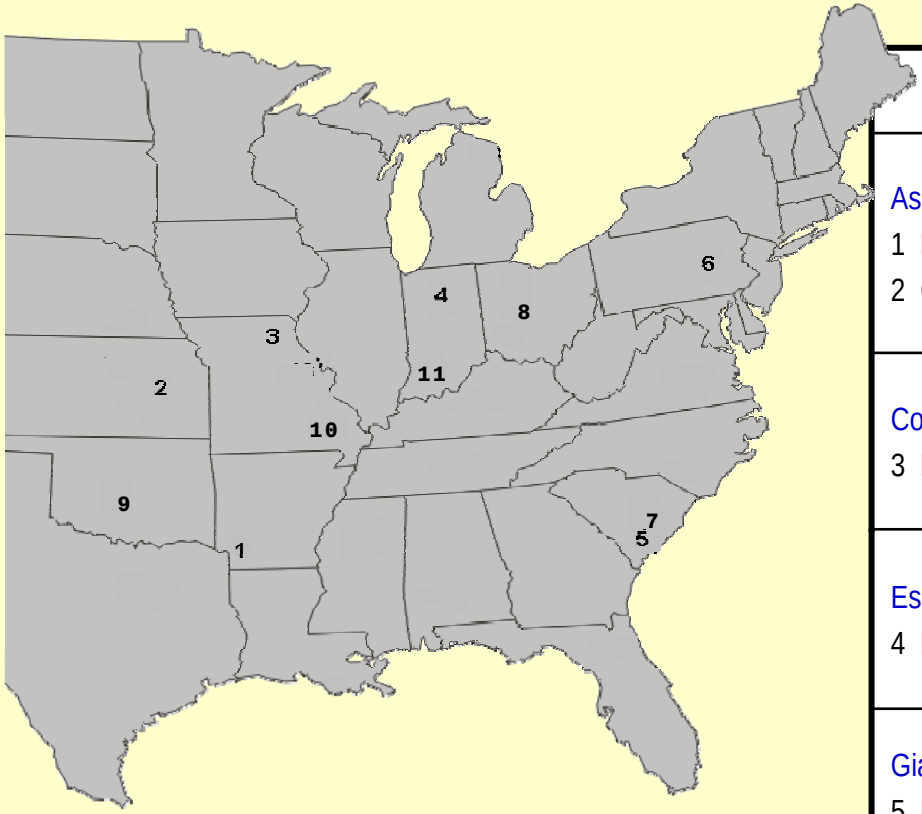
U.S. Cement Kilns Burning Hazardous Waste Derived Fuels (HWDF)



2012 (11 locations)

Ash Grove Cement 1 Foreman, Arkansas 2 Chanute, Kansas	Holcim Cement 7 Holly Hill, S. Carolina
Continental Cement 3 Hannibal, Mo	LaFarge Corporation 8 Paulding, Ohio 9 Tulsa, OK (New)
Essroc Cement 4 Logansport, Indiana	Buzzi Cement 10 Cape Girardeau, Mo 11 Greencastle, Indiana
Giant Cement 5 Harleyville, S. Carolina 6 Bath, Pennsylvania	Note: Eagle Materials currently looking at buying LaFarge's Tulsa, OK plant.

Note: All kilns are located in the mid-west and east coast, none on the west of the U.S.

U.S. Cement Kilns Burning Hazardous Waste Derived Fuels (HWDF)

- Only Two Kilns Burn Solid Hazardous Waste (in addition to liquids), i.e. Giant (SC), Continental (MO)
- Giant is permitted to substitute 100% waste fuel, typically achieves >50% to 70% Total (Calciner and kiln)
- Continental burns 40 to 50% substitution in calciner, permitted to burn in kiln but presently they do not burn waste in the kiln

Waste Burning & Sustainability

- US Portland Cement plants have reused 18.1 metric million tons waste fuel for energy recovery (last 20 yrs)
- Waste Burning is highly regulated through RCRA[1] and HWC-MACT[2] (waste & air rules)
- 907,100 mtons waste fuel avoids burning 862,800 mtons of coal on average

1 Resource Conservation and Recovery Act (1976)
2 Hazardous Waste Combustor Maximum Achievable Control Technology.

Waste Burning & Sustainability (cont.)

- 2.06 million metric tons per year CO_2 emissions avoided by burning Solvent Fuel in cement kilns vs. incinerators
- 0.479 million metric tons per year CO_2 emissions avoided by burning Solvent Fuel instead of a thermally equivalent amount of Coal
- Total CO_2 emissions reduction attributable to HWC cement kilns is 2.539 million metric tons per year

Waste Burning & Sustainability (cont.)

- Burning Waste Fuels is Political, Depending on the Administrator of the USEPA
- EPA Acknowledged CO_2 Emissions from Waste Fuels in Cement Kilns Should Not be Included for GHG Calculations/Reporting
- In 2008 EPA began to view waste fuel recycling as recovery and reuse opportunity
  (Cement Sector Trends Report by US EPA, October 2008, page 8)

Barriers of Entry

1. Regulations/Permits

1.52 Meters (5 ft) of Permits for a Single Kiln!!!
At a cost of $2.5 million!

Energy Sources for U.S. Cement Production

Table ES-1 Energy Derived from Fuels Used in Cement Production			
Fuel Type	**Quantity Used in Cement Production**	**Btus (billions) Used in Cement Production**	
Coal	9,997,231 tons	226,539.64	64.05%
Petroleum Coke	2,560,737 tons	74,900.71	21.18%
Natural Gas	12,723 million cu. ft.	12,939.29	3.66%
Middle Distillates	20,766,405 gallons	2,875.66	0.81%
Residual Oil	3,534,995 gallons	523.99	0.15%
Gasoline	1,485,385 gallons	185.61	0.05%
LPG	950,379 gallons	81.81	0.02%
Waste Oil	--	1,008.72	0.29%
Waste Solvents	--	14,026.48	3.97%
Tire Derived Fuel	--	12,622.12	3.57%
Other Solids	--	2,686.92	0.76%
Waste - Miscellaneous	--	5,311.63	1.50%
Total		353,702.58	100.00%
Source: PCA, U.S. and Canadian Labor-Energy Input Survey 2006			

Energy Sources for U.S. Cement Production Industry Tire Example vs Giant Cement HWDF

- In 2005, the Rubber Manufacturing Association reported 728,000 mton of scrap tires were used in cement production
- About 18% of total scrap tires generated
- Cement Sector Utilizes about 38% of scrap tire fuel market[1]
- As a whole this was about 3.6% of Energy for Cement Production
- Compared to Giant which Achieves 50 to 70% coal replacement!

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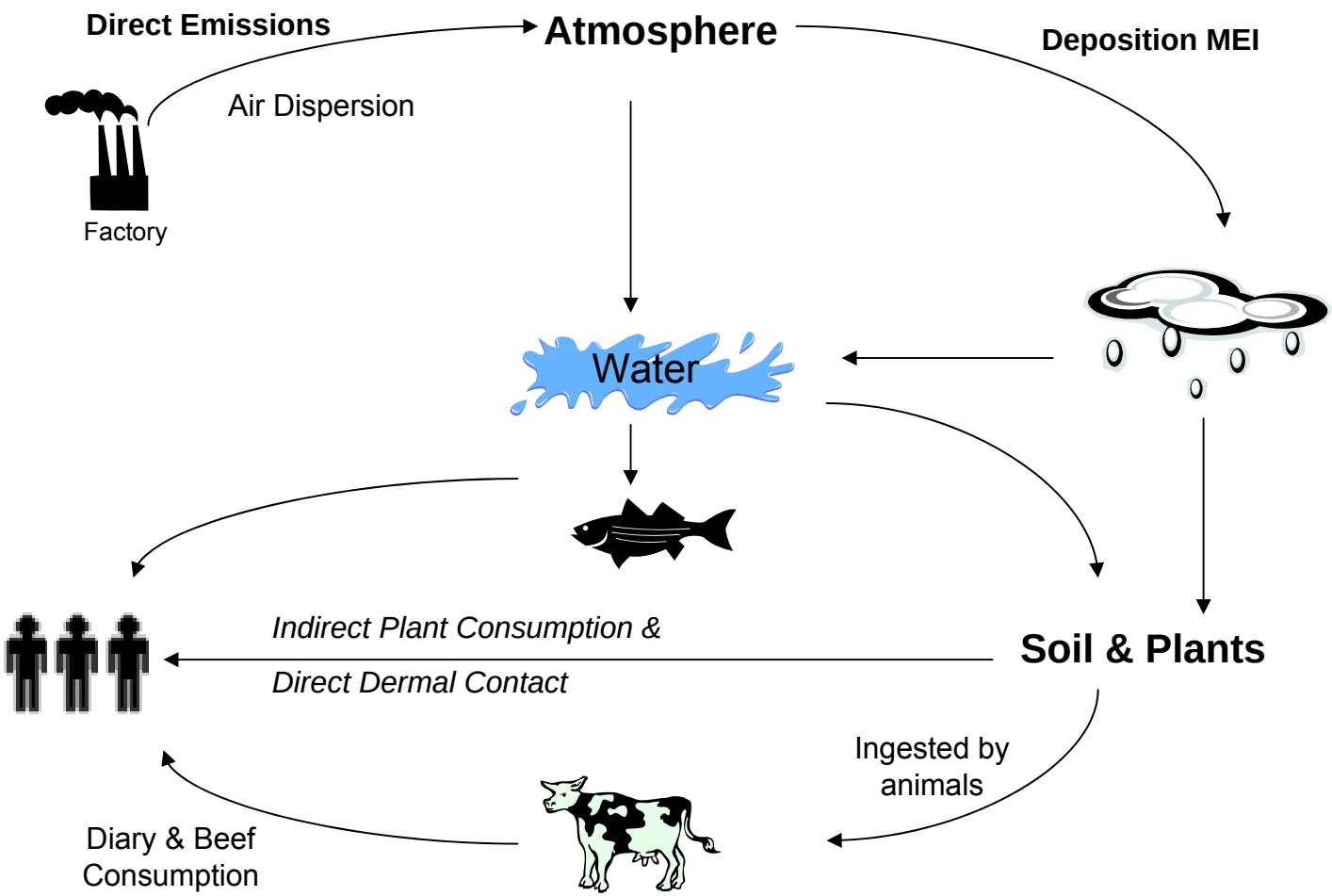
1 US Scrap Tires ≈ 40% fuel, 20% civil engineering, 8% ground rubber products, 4% rubber-modified asphalt, remaining 28% land fills, exported, misc. uses

EPA Requires Site Specific Human Health Risk Assessments (HHRA)

- Each HWC Facility Conducts HHRA
- Purpose to see if more stringent emissions limits should be set beyond the EPA Rules
- HHRA's Require Extensive Emissions Testing
- Apply Test Results to Exposure Pathways
  - Concentrations in soil, air, water, foods;
  - Amount taken into the body from these sources;
  - Inhalation and ingestion frequency (every day, once a month, etc.);
  - Duration of inhalation or ingestion (30 or 70 years).

HHRA Chemical pathways

Risk Evaluated Direct Emissions and Indirect Exposure



Regulated Metals/Chloride Feed-rate Control Based on HHRA & EPA Rules

Toxic Constituents Regulated

Antimony (Sb)	● Arsenic (As)	Barium (Ba)
● Beryllium (Be)	□ Cadmium (Cd)	● Chromium (Cr)
□ Lead (Pb)	Mercury (Hg)	Selenium (Se)
Silver (Ag)		Chlorine (Cl)

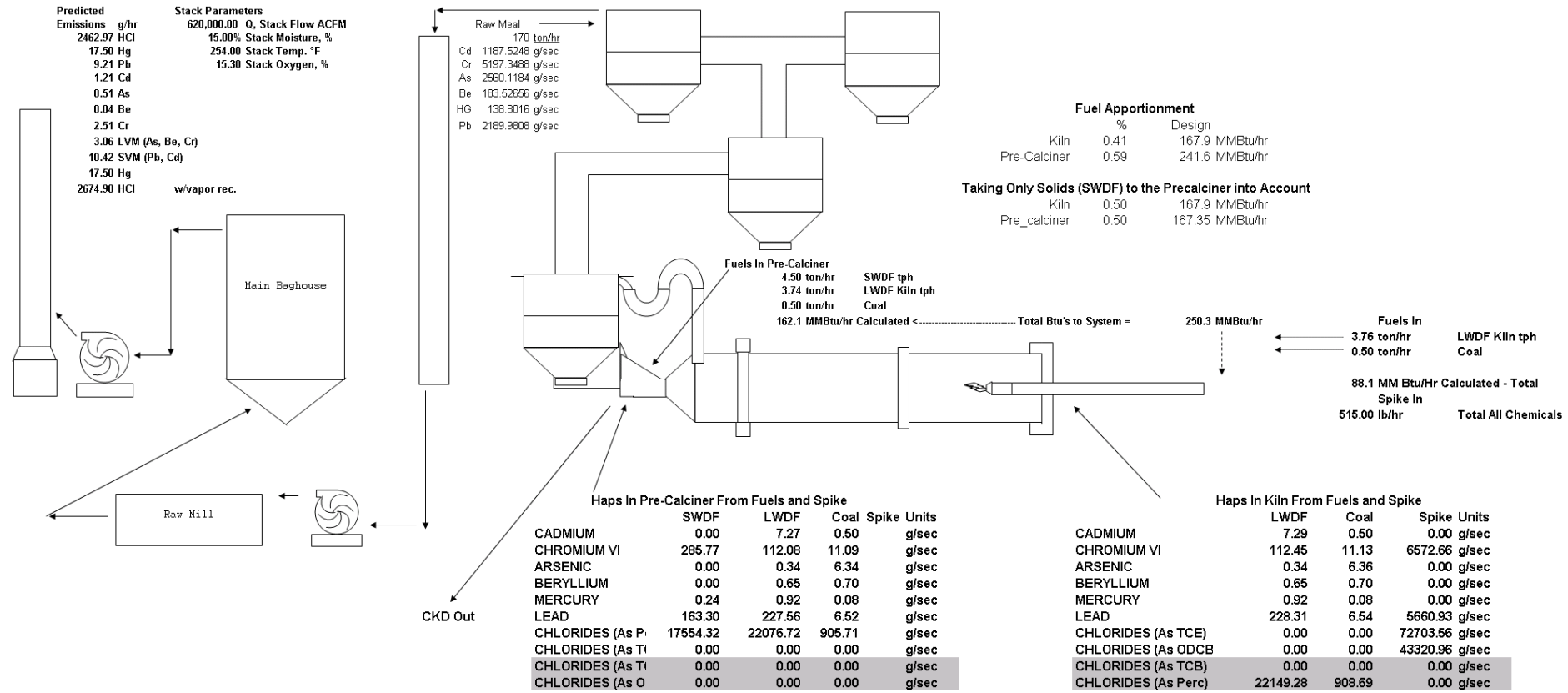
● LVM (Low Volatile)

□ SVM (Semi-Volatile)

Regulated Metals & Chlorides Through Feed-rate Control OPL's Giant Cement Example

Constituent	Total Feedrate (g/hr)	Averaging Period
LVM (Be, As, Cr)	39,458	12 - HRA
SVM (Cd, Pb)	608,866	12 - HRA
Mercury	1,218	12 - HRA
Chlorides	382,049	12 - HRA
Pollutant	**Basis**	**Limit**
THC (Bypass)	CEMs	10 ppmv
THC(First Stage)	CEMs	10 ppmv
PM (metals)	COMs	20% 6 min
D/F	APCD Temp.	<204°C
Destruction	Min. Kiln & Cal Temp	Test Specific

Computer Model Developed for Emissions Testing Accuracy is 99% Compared with Actual Stack Testing Used Real Time Along Side Emissions Test Company



Haps In Pre-Calciner From Fuels and Spike

	SWDF	LWDF	Coal	Spike	Units
CADMIUM	0.00	7.27	0.50		g/sec
CHROMIUM VI	285.77	112.08	11.09		g/sec
ARSENIC	0.00	0.34	6.34		g/sec
BERYLLIUM	0.00	0.65	0.70		g/sec
MERCURY	0.24	0.92	0.08		g/sec
LEAD	163.30	227.56	6.52		g/sec
CHLORIDES (As P	17554.32	22076.72	905.71		g/sec
CHLORIDES (As T	0.00	0.00	0.00		g/sec
CHLORIDES (As T	0.00	0.00	0.00		g/sec
CHLORIDES (As O	0.00	0.00	0.00		g/sec

Haps In Kiln From Fuels and Spike

	LWDF	Coal	Spike	Units
CADMIUM	7.29	0.50	0.00	g/sec
CHROMIUM VI	112.45	11.13	6572.66	g/sec
ARSENIC	0.34	6.36	0.00	g/sec
BERYLLIUM	0.65	0.70	0.00	g/sec
MERCURY	0.92	0.08	0.00	g/sec
LEAD	228.31	6.54	5660.93	g/sec
CHLORIDES (As TCE)	0.00	0.00	72703.56	g/sec
CHLORIDES (As ODCB	0.00	0.00	43320.96	g/sec
CHLORIDES (As TCB)	0.00	0.00	0.00	g/sec
CHLORIDES (As Perc)	22149.28	908.69	0.00	g/sec

Why an Alternative Fuels Program?

Cost Avoidance

PLUS

Revenue Enhancement

Alternative Fuels Burning Program

Critical factors to develop, evaluate and control in the selection of an alternative fuel:

- Accept only material that can be processed without negatively affecting the quality of the product. **[Cement manufacturer First and Foremost]**
- Develop an evaluation and acceptance program that ensures all environmental, health and safety standards are maintained.
- Communicate the Safe Program to all employees, neighbors, regulators and other stakeholders.

Alternative Fuels Burning Program

Criteria for the selection of alternative fuel:

- Heating value of the alternative fuel in BTU/lb
- Ash content of the alternative fuel
- Moisture content (%H2O) of the alternative fuel
- Halogen content (%Cl) of the alternative fuel
- Metal content of the alternative fuel (Product quality and Air Standards)

Typical Wastes accepted into the HWDF

LIQUIDS

- Organic Solvents
- Waste Oil
- Coolants
- Alcohols
- Off-Spec Fuels
- Paints
- Resins

SOLIDS

- Filter Cake
- Paint Solids
- Refinery Waste
- Carbon
- Resins
- Consumer Products
- PPE, Rags, Plastic, Debris

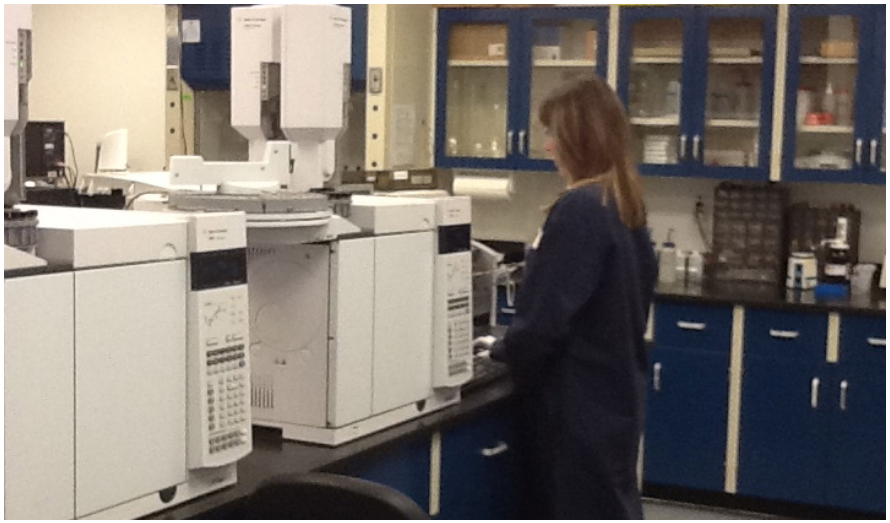
Grr-Harleyville HWDF Liquid Area

- **Waste burning at both the main kiln and calciner,**
- **20 tph maximum HWDF delivery rate to the kiln,**
- **Hazardous and Non-Hazardous Direct Burn Feed systems to the kiln,**
- **On-Spec Oil system for kiln start-up and shut-down,**
- **Heated non-hazardous tank system,**
- **290,000 gallon storage capacity Tank Farm,**
- **100 Drum permitted Storage Area,**
- **Material received by truck and rail,**
- **Approximately 14,000,000 gallons per year of liquids processed and burned**

Grr-Harleyville Solid HWDF Area

- 20,000 square foot processing and storage building,
- Building is vented to the kiln to control vapors and maintain required face velocity at door openings,
- Entire storage facility is equipped with a steel lined containment system,
- Material sizing preformed by three (3) nitrogen inerted shredders with a rate of 10 ton per hour,
- Storage facility continuously monitored by Infrared Flame Detection camera system and LEL monitoring instrumentation, with safety interlocks and automatic shut down features,
- Fire protection system that exceeds NFPA standards.

Analytical and Quality Testing of HWDF



- All potential material to be received must pass a strict review by management, environmental, safety and operational personnel before being accepted,
- Each load delivered must be sampled and analyzed prior to unloading into the processing areas, (>3,100 trucks annually)
- Grr-Harleyville has a very well equipped laboratory (> $500 K instrumentation) to analyze incoming material; (Feedrate control)
  - Instrumentation for wet tests- pH, Cl, H2O, BTU
  - Gas Chromatographs (PCBs)
  - ICPs (Metals)
  - Mercury analyzers
  - GC/MS (Organics)

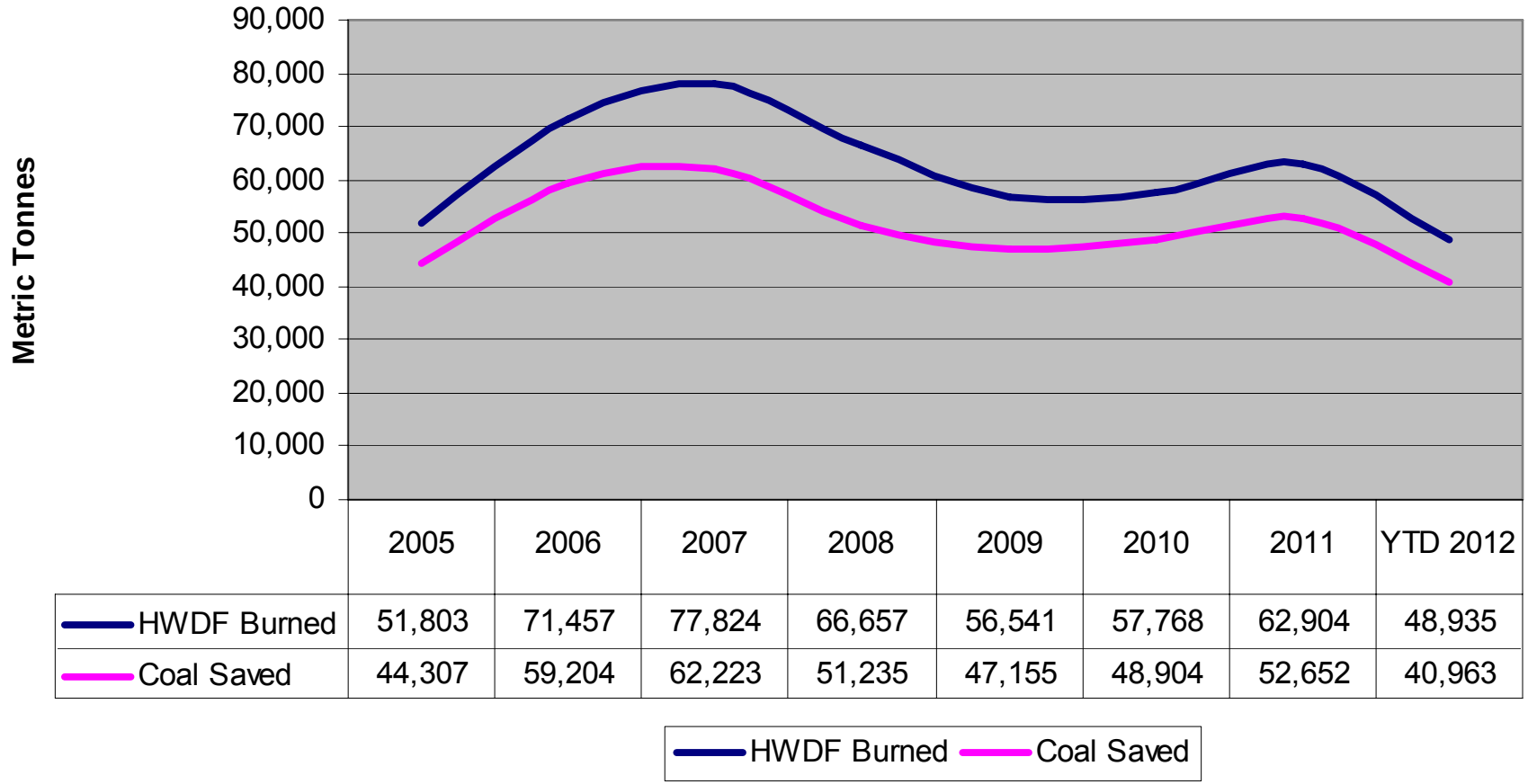
Results of Alternative Fuels Program

So what does the HWDF alternative fuels program provide to Giant Cement?

In the past 10 years:

- 1.8 X10^{13} BTU Replacement, (18 Trillion BTUs Replaced)
- 770,723 Metric tonnes of Coal saved,
- Average alternative fuels substitution rate of 63% of fuel usage.

HWDF Burned & Coal Saved



	2005	2006	2007	2008	2009	2010	2011	YTD 2012
HWDF Burned	51,803	71,457	77,824	66,657	56,541	57,768	62,904	48,935
Coal Saved	44,307	59,204	62,223	51,235	47,155	48,904	52,652	40,963

Material Arrives and Sampled

Solids Material for Processing

Solid Processing Equipment

Processing of Solid HWDF

Delivery of Solid HWDF to Kiln

Liquid HWDF Arrives and Sampled

Liquid HWDF Delivered to Kiln

Kiln Feed Pumps

LWDF Inlets to Kiln