RCRA 1976

The U.S. Congress finds with respect to energy,

(1) solid waste represents a potential source of solid fuel, oil, or gas that can be converted into energy;

(2) the need exists to develop alternative energy sources for public and private consumption in order to reduce our dependence on such sources as petroleum products, natural gas, nuclear and hydroelectric generation; and

(3) technology exists to produce usable energy from solid waste.

What Progress have we made?

42USC6901, Page 1474-1476

Successful Supply Marketing Shingles-to-Fuel to the Portland Cement Industry

Max Lee, Ph.D., P.E.
Koogler and Associates, Inc.

Shingle Recycling Conference
Dallas, October 28, 2011

- Think like a cement plant operator
- Shingles-to-fuel proven success for Portland cement
- The important questions to developing a business contract
- Navigating the new EPA definition to ensure your supply is not “solid waste”

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AVAILABLE SHINGLE SUPPLY

- **11 million tons of asphalt shingle waste generated in US each year**
  - 9.6 million tons from roofing tear-offs
  - 1.6 million tons from manufacturing scrap

- **Mostly disposed of in landfills**
  - Economically and environmentally cost effective to use as fuel

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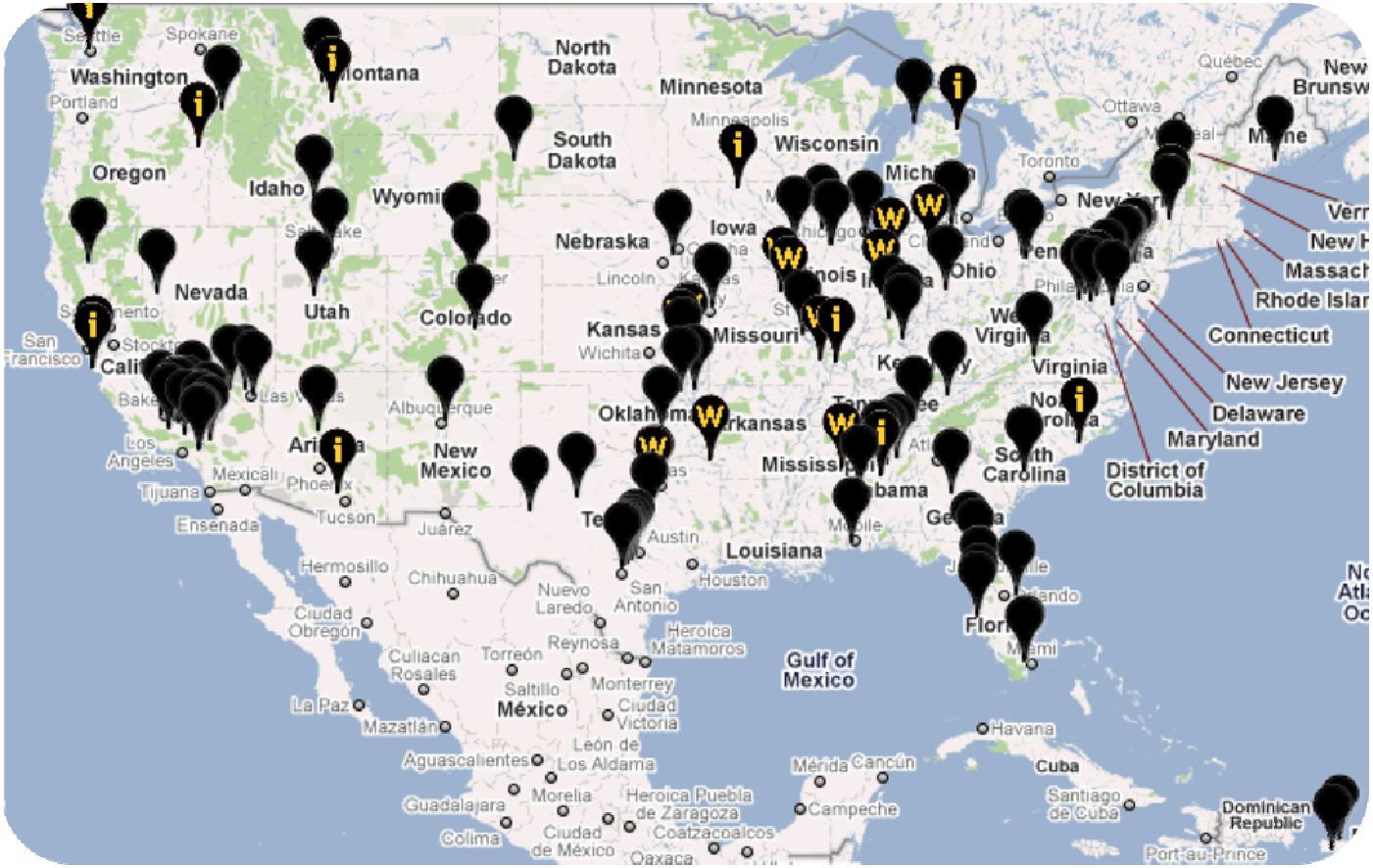

Contact Portland Cement Association for kilns near you

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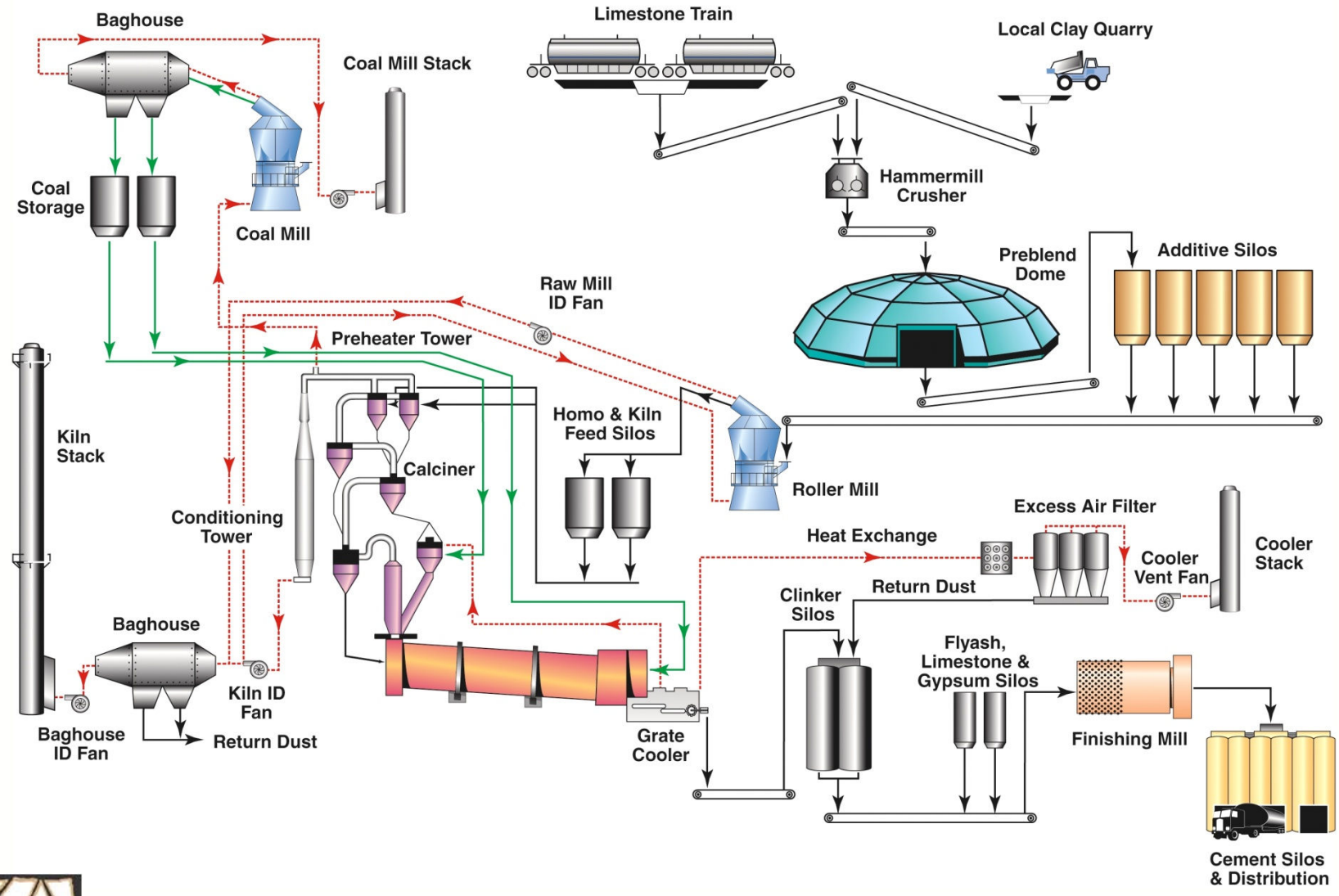
Think like a Cement Plant Operator

LEHIGH
HEIDELBERGCEMENT Group



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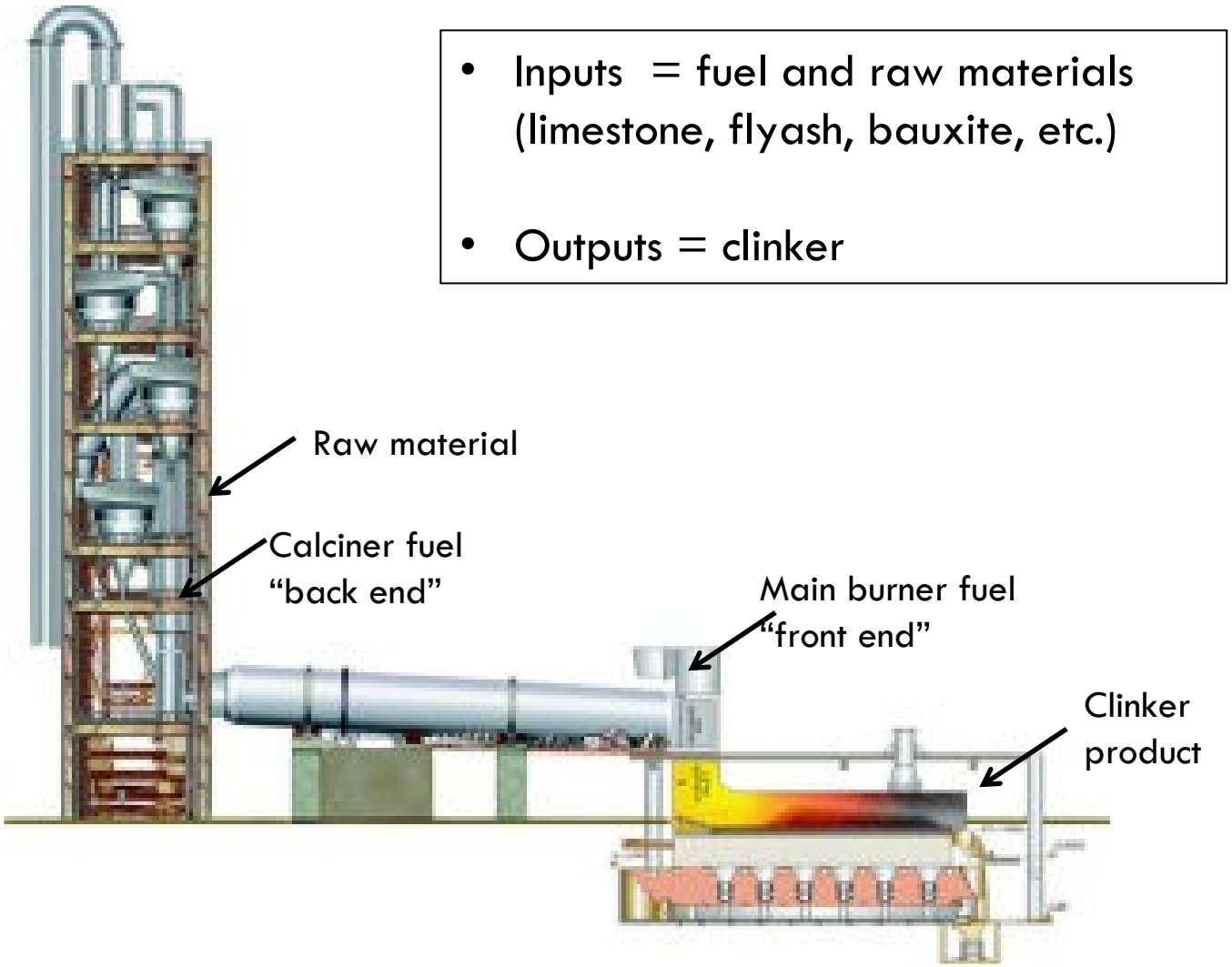
THE REAL WORLD

- Inputs = fuel and raw materials (limestone, flyash, bauxite, etc.)
- Outputs = clinker



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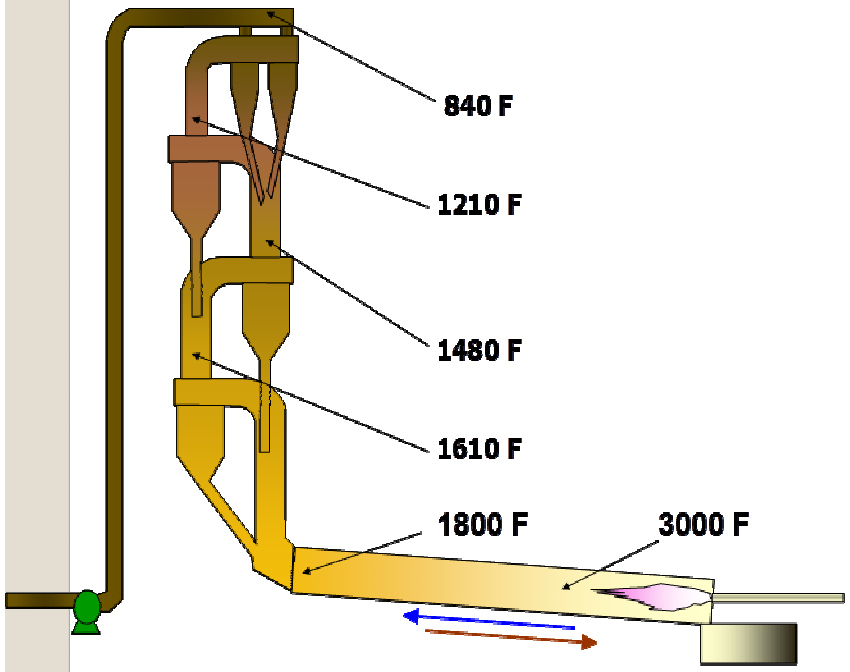
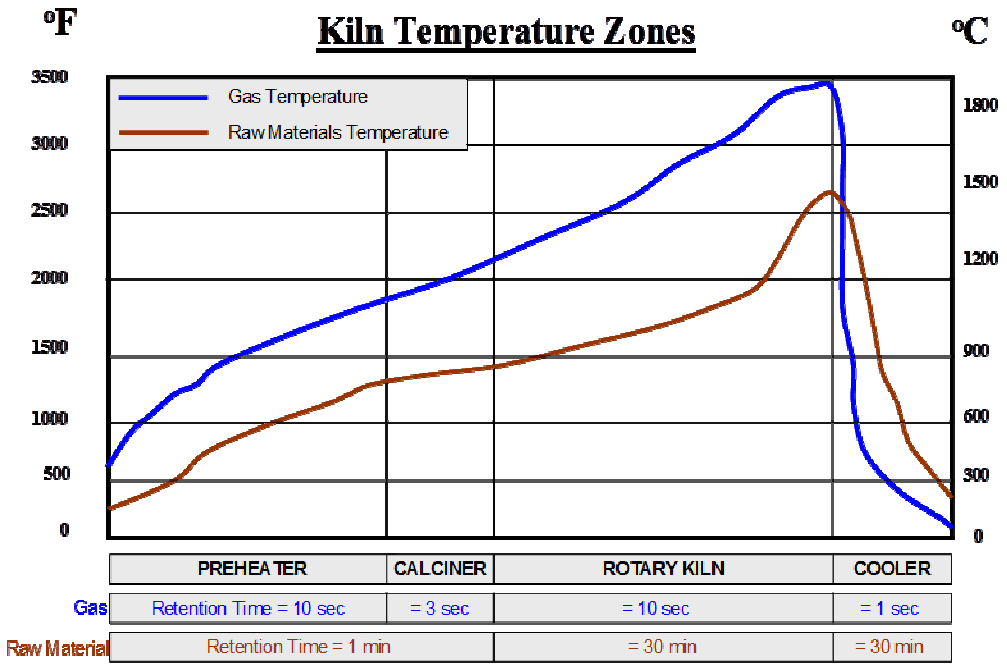
MODERN KILN





- The general reactions occurring through the temperature regions:
  - ≤ 750°F: water evaporation
  - 750 to 1350°F: mineral dehydration
  - 1100 to 1650°F: oxidation reactions, carbonate decomposition
  - 1475 to 2280°F: calcination of aluminates and silicates
  - 2300 to 3500°F: liquid phase clinker creation

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MODERN KILN

- Annual industry shipments estimated at:
  - $15.0 billion in 2006
  - $8.0 billion in 2010

- Fuel costs can represent 50%+ of operational costs
  - cost of traditional fuels increasing and variable

- Fuel Diversity - Lessons of coal pricing in 2005-2008

- U.S. cement industry lags behind - ranked 13th by World Business Council for Sustainable Development among those using alternate fuels
  - E.g., many European cement plants at ~80% heat replacement [1]

Source: www.wbcsd.org

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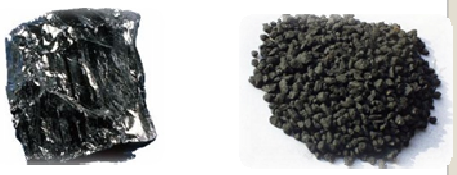
CEMENT ECONOMICS

Fuel Type	Percent Heat Input in US[1]	Usage
Coal	64.%	10 million tons
Petroleum Coke	21.%	3 million tons
Natural Gas	3.6%	14 mmft^3
Tires[3]	3.6%	0.5 million tons
Oils	0.2%	Only for startup



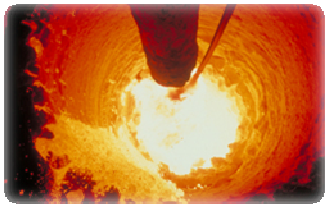
[1]International, I. *Trends in Beneficial Use of Alternative Fuels and Raw Materials*. 2008; Available from: http://www.epa.gov/sectors/pdf/cement-sector-report.pdf.

TYPICAL FUEL

Four Criteria to Successful Shingle-to-Fuels

- Handling and Storage

- Ensure Kiln Infrastructure Integrity



- Produce a Quality Cement Product

- Maintain or Improve Environmental Emissions and Sustainability

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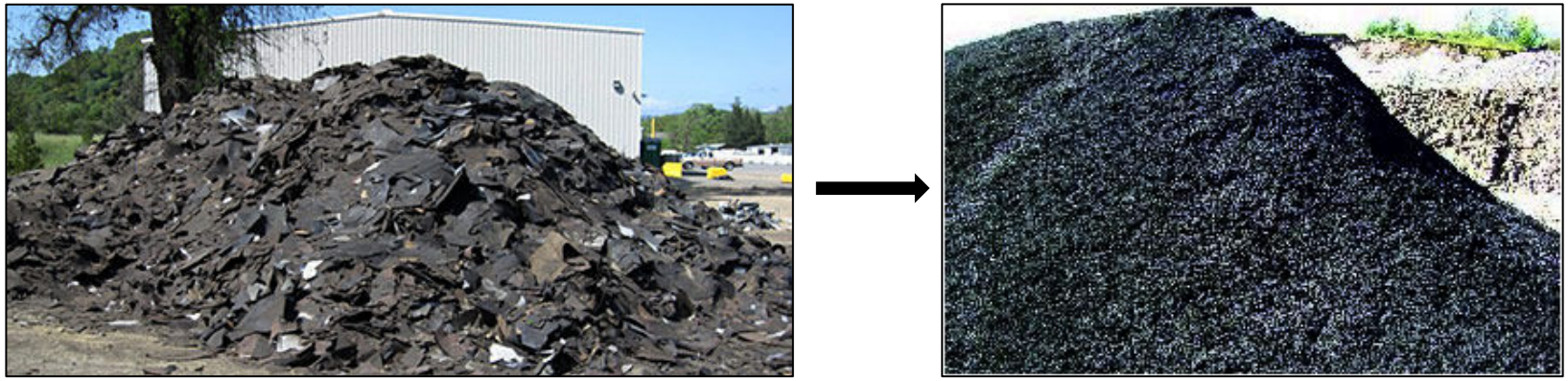
THE REAL WORLD

- Shingles must be sized (grinding/chipping).
  - Sieve out the aggregate. Fuel is the bitumen (asphalt). Develop a repeatable sizing analysis procedure to estimate agg in mix.
  - Consistent size critical to combustion
- Roofing Tear-Off Shingles
  - Critical to blend many sources to reduce fuel variability
- On-site vs. off-site grinding/shredding = less handling/transport costs



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PROCESSING SHINGLES FOR FUEL

- Combustion must be well-controlled which demands consistent fuel properties
- Primary properties of concern
  - Heat content
  - Phosphorous
  - Alkalis
  - Sulfur
  - Moisture

Shingles – must focus on heat content (blend old and new shingles)

KILN INFRASTRUCTURE

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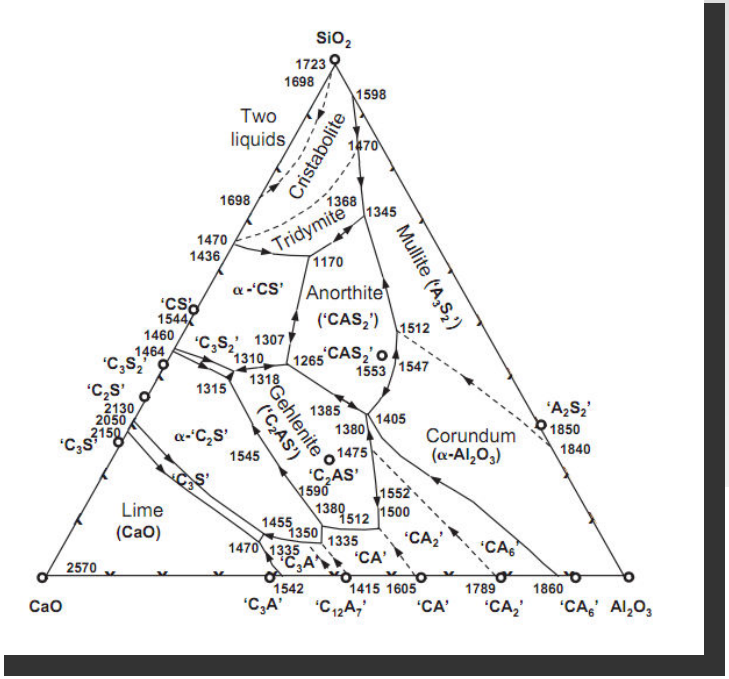
Ternary Phase Diagram of Cement Manufacture[1]
(SiO_2 vs. A_2S_2 vs. CaO)



- Chemistry involved in cement manufacture can be affected by the mineral concentrations in alternative fuel ash

- Metals, e.g., chromium, nickel
- Phosphorous
- Alkalis
- Sulfur

- Can create undesirable effects in cement
  - Reduced strength
  - Increased setting time
  - Color

Processed shingles should not have significant impact on chemistry

[1]Kauffman, G., *Cement: Its Chemistry and Properties,* Department of Chemistry and Institute for Research in Materials, Dalhousie University. Available from: http://myweb.dal.ca/mawhite/3303/supplementals/cementpaper.pdf

CEMENT QUALITY

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No debate – shingles-to-fuel are desirable cement kiln fuel

Examples

- St. Mary's Cement: Charlevoix, Michigan
- Lafarge: Brookfield, Nova Scotia

Air emissions – neutral or improvement

Asbestos (what little may be present) will be destroyed in kiln[1]

No ash residue

- EPA and European Union promote use of shingles as fuels for cement kilns
- 6/17/11 -EPA stated in FR notice that pollutant emissions the same or lower when alternative fuels used in cement kiln.

1 from: http://www.osti.gov/bridge/servlets/purl/927606-pt5qkC/927606.pdf

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ENVIRONMENTAL BENEFITS

- Traditional fuel concerns; coal, natural gas, nuclear
- Sustainability
  - Local activity= local investment dollars
  - Conservation by diverting waste from disposal
  - Reduce landfilling
  - GHG benefits – air permits
- Studies show there is a limit to fraction of waste that can be recycled
- The U.S. may have a Renewal Portfolio Standard someday…
  - State and local initiatives

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SUSTAINABILITY

The important issues to developing a business: processing and contracting

Pre-negotiation review

- buyer permits (air and solid waste)
  allow for shingles, tear-off and reject
- review waste flow control issues, e.g., Chicago, Miami, NE U.S.

Negotiating your supply

- Material sampling and analysis
- Specify range parameters: e.g., ranges of heat content, moisture, metals…
- Processing and sizing requirements
- Price limits/floor, timing
- Quantity floor/ceiling
- Who pays for transportation expenses
- Allowed alternative sourcing (negotiate with other suppliers)
- Time terms of payments
- Provisions for Force majeure

Promoting the Market

- Need for shingle industry templated contracts

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CONTRACTING

COST COMPARISON

Shingles delivery not included		**Traditional Fuel (coal) delivered**	
Tipping Fee	$20		
Staging & Testing (var.)	$5		
Chipping	$13		
Sieving	$8		
Blending	$5		
Storage & Loading	$1.50		
Total:	$52.5/ton	Average Expense:	$80-160/ton
avg. heat content	11,000 btu/lb	avg. heat content	13,000 btu/lb
Cost/heat content	$2.40/mmbtu	Cost/heat content	$3 - 6/mmbtu

- The comparison should be based on heat content not mass!

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Ensuring your Shingle-to-Fuel is not Solid Waste

NHSM Rule (40 CFR 241) – Identification of Solid Waste

Are my shingle-to-fuels a "solid waste"?

- Legitimacy Criteria
  - Sufficiently Processed – more than just size reduction
  - Valuable Commodity – proper handling and storage
  - Heating Value – generally > 5,000 btu/lb (as fired)
  - **How to Compare Contaminants – The Multi-Billion Dollar Question!**

Kiln owner/operator responsibility but shingle supplier can provide support to promote the contract

1) Determine all possible traditional fuels (40 CFR 241.2) units is “designed to burn”
2) Determine which contaminants to evaluate- Critical Issue!
3) Gather all available sources traditional fuel and shingle contaminant information
4) Compare each contaminant either units of ppm or lb/mmbtu.
5) Document your comparison!
6) Be alert for new EPA guidance, rulemaking, or legislation – keep in touch with your trade associations, consultants

Note that NHSM rule will be re-proposed end of November !

Recommendations for Shingle Recycling Organization

Develop a Shingle-to-Fuel Committee

- Develop standards for materials analysis (sizing, purity, asbestos)
- and procedures
- Develop contracting conditions
- Marketing/Communication
- Promote demonstration grinding systems on-site cement plants

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DEVELOP THE MARKET

Further reading -

C&D World magazine - May/June – Part I

C&D World magazine - Sept/Oct – Part II

CementAmericas – Sept/Oct

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QUESTIONS?