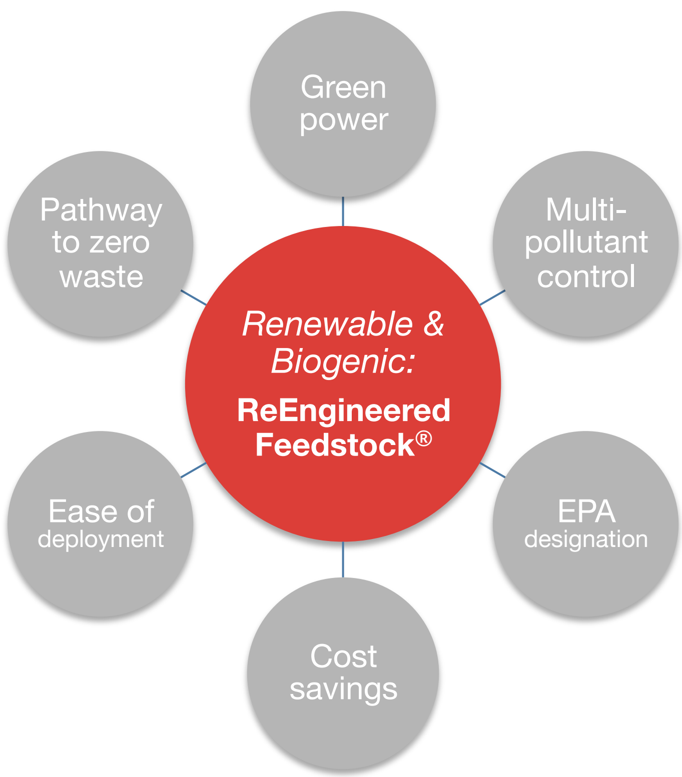
ReEngineered Feedstock:
An Advanced Renewable and Alternative Fuel For Co-Firing in Cement Calciner and Main Kiln Burners



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Executive Summary

- ReEngineered Feedstock is a precisely-engineered product of advanced manufacturing technology that enhances the separation and recovery of marketable recyclable commodities from otherwise non-recyclable municipal solid waste (MSW) materials, including organic fibers (typically paper, cardboard and similar packaging materials) and plastics that would be landfilled due to quality issues.
- Co-firing ReEngineered Feedstock directly reduces greenhouse gas (GHG) emissions for cement plants, leading to significant compliance cost savings. For example, ReEngineered Feedstock can substantially lower GHG compliance costs for California cement plants as the biogenic portion of ReEngineered Feedstock would qualify as a biomass-derived fuel that does not trigger a compliance obligation under the state's Cap-and-Trade Program. This Program requires cement plants to obtain and retire carbon credits sufficient to cover their GHG emissions, with such credits currently trading at over $13 per metric ton of GHGs emitted. This regulatory burden would grow under a recent proposal by the California Air Resources Board to reduce allocations of free allowances to cement plants 26% post-2020. Notably, cement plants already possess a carbon pricing incentive to purchase ReEF as such plants would be able to sell any freely allocated allowances that are surplus after accounting for ReEF's lower carbon intensity. In other words, lowering a cement plant's compliance obligation before 2020 via use of ReEF can generate immediate cost savings. Further, new federal and/or regional GHG regulations likely will create opportunities for additional cost savings via the use ReEngineered Feedstock (e.g., via facilitation of compliance with expected GHG emission performance standards for cement manufacturing).
- Co-firing ReEngineered Feedstock – which the United States Environmental Protection Agency (EPA) has determined is a non-waste fuel, not a solid waste – can have tremendous regulatory and cost-saving benefits for cement plants when compared with co-firing MSW. Under the recently promulgated federal Clean Air Act (CAA) standards discussed herein, cement kilns that co-fire ReEngineered Feedstock will be subject to the generally less stringent air emission limits applicable to cement kilns, rather than the more onerous air emission limits applicable to commercial and industrial solid waste incinerators. Accordingly, co-firing ReEngineered Feedstock can improve the air emission profiles of cement kilns, while simultaneously easing the operating costs and constraints on such units.
- The ReEngineered Feedstock production process reduces overall landfill disposal to just 35% of the total waste stream. Accordingly, use of ReEngineered Feedstock at cement plants would support an integrated waste management system, helping local communities to achieve higher rates of landfill diversion, recycling, and resource utilization.

Introduction

Reducing GHG emissions is a high priority for governments across the globe and there is a particularly aggressive regulatory scheme in California. Accordingly, the increase in the use of renewable and alternative fuels for cement clinker production is of high importance for cement manufacturers. Cement is considered one of the most important building materials in the world, and a key industry from an economic, energy and air emission perspective. In 2015 alone, manufacturers produced approximately 4.3 billion tons of cement globally. The United States is the world's third-largest cement producer, producing roughly 118 million tons per year total in 34 states. Approximately 9.8 million metric tons of cement was produced in California in 2015.

Cement manufacturing is a GHG emissions-intensive process. Approximately 50% of emissions come from the chemical reaction that converts limestone into clinker, the active component in cement. Another 40% of the emissions come from fuel combustion, and the remaining 10% of the emissions come from associated transportation and electricity consumption. The energy required for the chemical reaction typically has been provided by burning coal or petroleum coke, two of the most carbon-intensive fossil fuels. The energy-intensity of the process, consuming thermal energy of about 3-5 million British Thermal Units per ton (mmBtu/ton) of cement, and 110-120 kilowatt hours per ton (kWh/ton) of electricity, presents major challenges as the cement production industry seeks to respond to customer and regulatory pressures to reduce its GHG emissions. As coal has been the primary fuel utilized in cement kilns, cement production historically has been a significant source of combustion-related GHG emissions – averaging approximately 0.507 short tons of carbon dioxide per ton of clinker produced.[1]

Until recently, “cement” usually referred exclusively to Portland cement. In today’s market, Portland cement is used in combination with other cementitious materials such as fly ash and slag. Portland cement is made by heating suitable raw materials, typically ground limestone and clay, at a temperature of about 1450 degrees Celsius to produce a dark grey nodular material called clinker. When cool, the clinker is ground up to a fine powder and a small amount of gypsum is added to control the setting properties of the cement.

Cement producers worldwide are challenged to lower their production costs and GHG emissions. Replacing coal and petroleum coke with lower-carbon renewable and alternative fuels is the most substantial short-term opportunity to reduce GHG emissions from the cement sector. Alternative fuels have been effectively used in many parts of the world for more than 20 years, where substitution rates exceed 30%. Replacing a portion of fossil fuels with renewable and alternative fuels is economically and environmentally desirable, and technologically achievable today.

ReEngineered Feedstock

ReEngineered Feedstock is a precisely-engineered product of advanced manufacturing technology**,** which enhances the separation (and therefore recovery) of marketable recyclable commodities from otherwise non-recyclable MSW materials, including organic fibers (typically paper, cardboard and similar packaging materials) and plastics that would be landfilled due to quality issues. Those materials are specifically selected by rejecting and removing unwanted components, such as polyvinyl chloride (PVC), to create an engineered fuel that matches the desired heating profile and emissions reduction needs of specific coal-fired combustors like utility boilers and cement kilns. The advanced ReEngineered Feedstock manufacturing process is depicted in Figure 1.

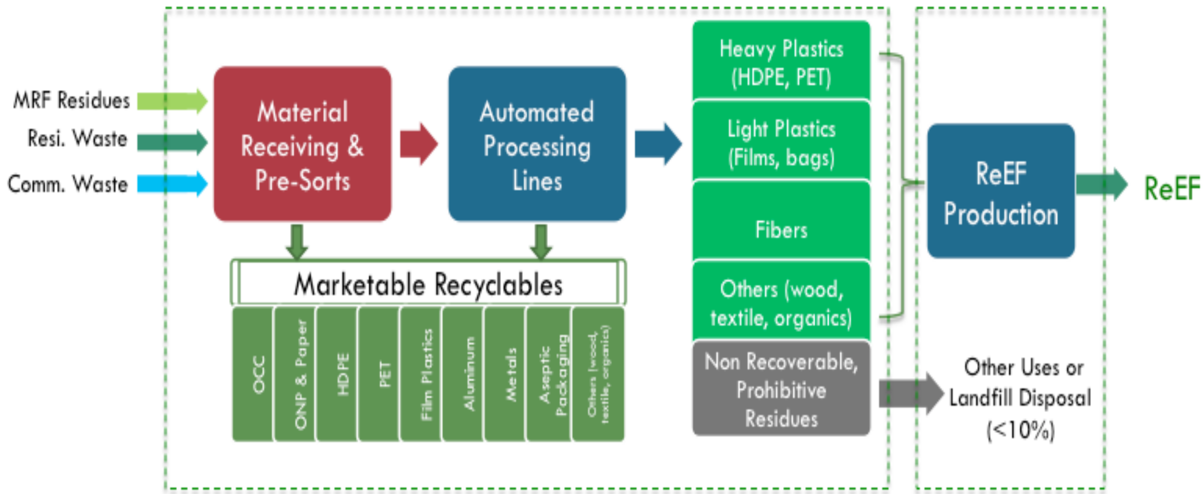

Figure 1 Schematic of a representative ReEngineered Feedstock manufacturing process

ReEngineered Feedstock products for combustion in preheater kilns, calciners/pre-calciners and main kiln burners are precisely-engineered with regard to particle size, physical and chemical compositions, material density and transport characteristics to optimize combustion and minimize impact on clinker characteristics. Recognizing that each cement plant and clinker formulation may require different fuel characteristics, the ReEngineered Feedstock fuel formulation is customizable to allow for the manufacturing of high-performance Portland cement clinker.

ReEngineered Feedstock product configurations are application-specific and may be pelletized or offered in a free-flowing fluff format, as pictured in Figure 2.

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1 EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014 (April 15, 2016). https://www.epa.gov/sites/production/files/2016-04/documents/us-ghg-inventory-2016-main-text.pdf.

Figure 2 Typical ReEngineered Feedstock product configurations

To ensure a cement kiln's stable operation and product quality, the cement manufacturing process requires a well-defined fuel that has a consistent and known physical and chemical characteristic, a high calorific value, and controllable containments level. Compared to other competing waste-derived fuels, ReEngineered Feedstock is precisely designed and engineered to achieve these goals.

Use of ReEngineered Feedstock in Cement Kilns (Calciners and Main Burners)

Renewable and alternative fuel utilization in cement kilns is growing. While in some kilns up to 100% substitution rates have been achieved, in others, permitting regulations and access to waste markets cannot support this high rate of alternative fuel utilization. Although the use of alternative fuels for the production of Portland cement clinker can substitute for coal and other fossil fuels, careful engineering of the alternative fuel is needed to minimize adverse impacts on clinker properties.

In most kiln systems, modifications to the combustion process to enable the utilization of alternative fuels are minimal. Multi-channel burners used today, which are designed for the use of alternative fuels, allow for control of the flame shape to optimize the burning performance of the fuel and the combustion conditions conducive for the production of clinker.

In preheater kilns, those without calciners, it is usually possible to burn alternative fuels in the kiln inlet at substitution rates of up to 30% and, as a result, 70% of the fuel has to be fired in the main kiln burner. In precalciner kilns, usually 65% of the total energy is fired into the calciner, leaving the remaining 35% to be fired in the main kiln burner.

On average, the utilization of ReEngineered Feedstock can replace up to 50% of coal used in calciners and up to 30% of the coal used in main kiln burners, and at the same time offers an economically viable waste management option to local communities. Use of ReEngineered Feedstock at cement plants supports movement toward an integrated waste management system, helping local communities achieve higher rates of landfill diversion, recycling and resource utilization.

As a high-quality renewable and alternative fuel, the ReEngineered Feedstock is manufactured and can be utilized in full compliance with national policies on energy efficiency, climate change, air emission and waste management. Protected by a broad portfolio of issued and pending patents, ReEngineered Feedstock is a non-waste fuel under the Non-Hazardous Secondary Material (NHSM) rule and has received a non-waste fuel determination from the EPA in accordance with federal regulations (40 CFR 241.3(b)(4)). Furthermore, to specifically benefit cement plant operations, ReEngineered Feedstock is designed and manufactured to have constant and homogeneous physical and chemical characteristics.

As a predominately renewable fuel, the use of ReEngineered Feedstock in cement kilns has the potential to reduce GHG emissions commensurate with the reduced use of conventional fossil fuels, and to conserve non-renewable resources. Figure 3 compares carbon dioxide (CO_2) emission factors of ReEngineered Feedstock and other common fossil fuels.

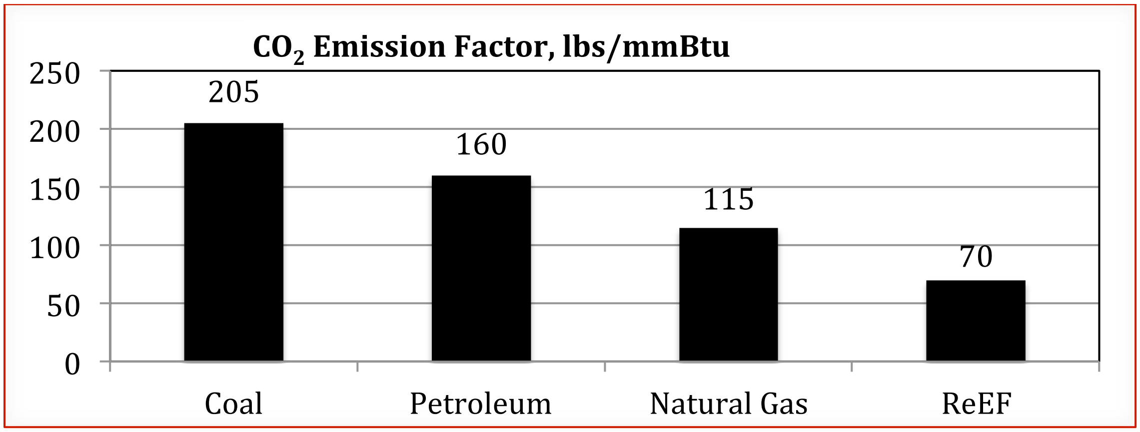

Figure 3 CO_2 emission factor for ReEngineered Feedstock, coal, petroleum, and natural gas.

In comparison to other alternative fuels, MSW represents the only long-term reliable and cost-effective feedstock for alternative fuels for cement plants, and thus the most dependable strategy to reduce the cement industry's GHG emissions intensity.

Typical Firing Points for Alternative Fuels

The traditional firing points in a cement kiln are the calciner and kiln burner. ReEngineered Feedstock has been designed to optimize combustion with the relatively small fuel particles to ensure the desired flame profile in the kiln burner and sufficient fuel burnout in the calciner.

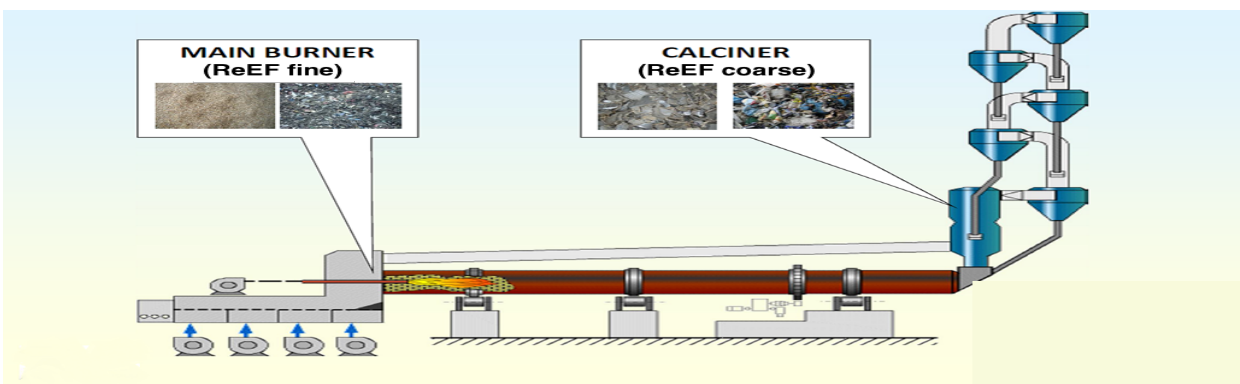

Figure 4 Potential kiln firing points

Fundamentally, combustion of a solid fuel particle, which is commonly characterized by the so-called proximate analysis and the ultimate analysis, involves a number of steps: drying; devolatilization; and char combustion. Figure 5 shows solid fuel particle combustion. In practice, solid fuels are burned in a variety of systems, including pulverized boilers, fluidized bed combustors, stoke or grate furnaces, or kilns. Each such combustion system influences how a solid fuel is combusted because it provides different combustion environment conditions. In some systems, a solid fuel particle, with varying shape, size and density, takes these steps in sequence, and in other cases, the steps would occur substantially simultaneously. Normally, as the fuel particle size gets smaller, especially for high volatile content fuels such as biomass, fibers, and plastics, which comprise waste-derived fuels such as ReEngineered Feedstock, it heats up more rapidly when it is injected and exposed to the combustion flames. Within a few milliseconds, the moisture or water contained in the fuel particle is driven out to become steam, which can participate in further chemical reactions (such as pyrolysis or gasification, water-gas shift reaction, etc.), or stays as water vapor. This process essentially is complete as inside particle temperatures exceed 212 degrees Fahrenheit. As the fuel particle is heated further, it devolatilizes, a process that involves the release of methane, carbon oxides, steam, and other higher molecular hydrocarbons, which can be liquid, gaseous or both. As the volatiles formed within the fuel particle escape to the surrounding atmosphere, the molecular structure of the fuel particle is cracked by vigorous jetting as flow channels open in the char to allow the release of the high pressures built up by volatile production in the core of the particle. Completion of devolatilization leaves a highly porous char, which is then combusted when oxygen is continuously supplied. Finally, the combustion processes leave the non-combustible residue (i.e., ash) as the final combustion product.

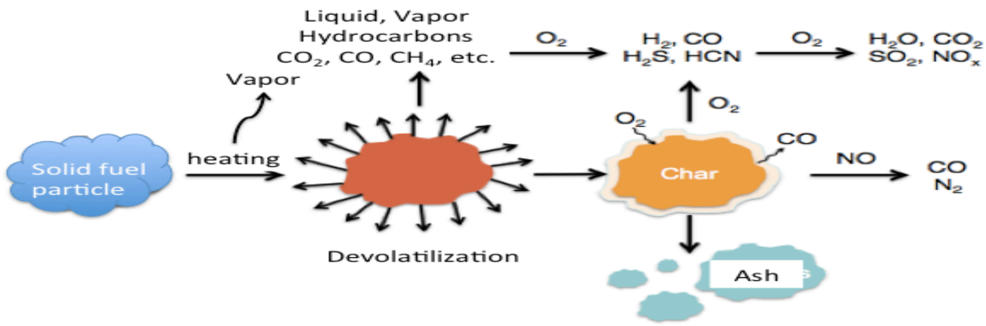

Figure 5 Solid fuel particle combustion process

Fuel Analysis of ReEngineered Feedstock

The fuel analysis for ReEngineered Feedstock and other alternative fuels is presented in Table 1 below. The values are approximate, and may vary depending on the material source and processing required for individual calciners and main kiln burners. However, the values depicted provide indications of heating values and elemental composition of various fuels.

Table 1 Common Alternative Fuels Used in Cement Production

	Proximate analysis			Ultimate analysis								Lower heating value	Reference
	VM[a]	FC[b]	Ash	C	H	N	S	Cl	O[i]	Na	K		
Wood[c]	79-83	15-17	0.3-0.5	49-51	5.8-6.0	0.06-0.07	0.01-0.03	-	36-44	-	-	19.7-19.8[j]	Hassan et al., 2009 Gaur & Reed, 1998
RDF[d]	60-84	2-16	8-32	42-72	5-11	0.8-2.4	0.1-0.6	0.1-3.9	3-36	0.1-0.2	0-0.1	14	Tokheim, 2005 & Kobyashi et al., 2005
TDF[e]	54-56	23-30	7-23	64-81	5.6-7.2	0.3-0.5	1.4-1.6	0.15	2.0-5.6	~0	~0	31.0-32.8	Chen et al., 2001 Larsen, 2007 Chinyama et al., 2007
PE[f]	100	~0	~0	86	14	~0	~0	~0	~0	~0	~0	40.2-44.2[j]	Panagiotou, T., 1994 Wang, Z. et al., 2004
PVC[g]	91	9	1	38	5	~0	~0	57	~0	~0	~0	19.2[j]	Panagiotou, T., 1994 Wang, Z. et al., 2004
ReEF[h]	82	3	7	58	8	0.11	0.07	0.01	20	0.01	0.01	11,220 Btu/lb	Measured

a) Volatile matter
b) Fixed carbon (char)
c) Pine wood
d) Refuse derived fuel
e) Tire derived fuel
f) Polyethylene
g) Polyvinyl chloride
h) ReEngineered Feedstock
i) By difference
j) Lower heating value calculated from higher heating value

Use of ReEngineered Feedstock, a Non-Hazardous Secondary Material, is not waste incineration or waste-to-energy

Co-firing ReEngineered Feedstock as a renewable and alternative fuel in cement production is different from traditional incineration in several ways. The high temperatures and longer residence time of cement kilns allows for a more complete combustion of fuel and, as a result, lower air emissions. Unlike incineration, the cement manufacturing process produces very little residual waste, as the majority of non-combusted residual material is incorporated into the clinker.

The production and use of ReEngineered Feedstock and the resultant impacts on solid waste management and recycling are also different from incineration. ReEngineered Feedstock is produced from the non-recyclable components of the solid waste stream, strengthening incentives to maximize waste reduction and recycling. The capital-intensive construction of new solid waste incinerators or energy generation facilities requires predictable, long-term supplies of solid waste to ensure the financial viability of the incinerator or energy generation facility. The capital required to construct a ReEngineered Feedstock manufacturing facility – which produces a renewable, alternative fuel, recovers recyclable material, and reduces overall landfill disposal to 35% of the total waste stream – is a fraction of the capital expense of a solid waste incinerator.

Importantly, cement plant fuel substitution with ReEngineered Feedstock will not reduce incentives for recycling. Several studies of the role of energy recovery, recycling and mixed waste processing in solid waste management have found that alternative fuels derived from sorted wastes do not negatively impact recycling rates. In fact, a European Commission study[2] and the American Forest & Paper Association Mixed Waste Processing Economic and Policy study[3] concluded that the use of legitimately produced alternative fuels derived from sufficiently processed solid waste could be a strategic element of an integrated solid waste management system and would help facilitate higher diversion rates through the use of non-recyclable components of the waste stream (e.g., via the production of ReEngineered Feedstock).

The beneficial impacts on emissions from cement manufacturing of using ReEngineered Feedstock, in contrast to using other alternative fuels, are significant and include:

- Nearly total neutralization of acid gases (sulfur oxides and hydrogen chloride) by the active lime in the kiln load, in large extent to the stoichiometry, can be achieved;
- High residence time and high temperature in the furnace makes possible the complete destruction of organic compounds and retaining of polychlorinated dibenzodioxins and dibenzofurans (PCDD/DFs);
- Embedding of the traces of heavy metals in the clinker structure with very stable links (metallic silicates formation); and
- No production of by-products such as ash or liquid residue from gas cleaning.

ReEngineered Feedstock Has a Better NO_x Emissions Profile Than Natural Gas

While utilizing natural gas in place of coal or petroleum coke would reduce aggregate GHG emissions, natural gas-fired kilns also can significantly increase nitrogen oxides (NO_x) due to the higher flame temperatures. Typical pre-heater, pre-calciner kiln systems combusting coal have a range of 1.35 to 1.95 kilograms (kg) of NO_x per ton of clinker produced, compared to 1.7 to 3.0 kg of NO_x per ton for natural gas.[4]

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2 Directorate General Environment, *Refuse Derived Fuel, Current Practice and Perspectives* (European Commission, 2003). http://ec.europa.eu/environment/waste/studies/pdf/rdf.pdf

3 American Forest & Paper Association, *Mixed Waste Processing Economic and Policy Study*, (2015). http://afandpa.org/docs/default-document-library/final_mixed-waste-processing-economic-and-policy-sutdy.pdf

4 U.S. Environmental Protection Agency, *Alternative Control Techniques Document Update: NO_x Emissions from New Cement Kilns,* EPA-453/R-07-006 (2007). http://www.epa.gov/ttncatc1/dir1/cement_updt_1107.pdf

Benefits of Co-Combustion of ReEngineered Feedstock with Coal

- Reduces fossil-based carbon dioxide (CO_2) emissions
- Reduces carbon monoxide (CO) emissions
- Reduces nitrous oxide (N_2O) emissions (the capacity of N_2O to contribute to the warming of the atmosphere, a measure known as the global warming potential (GWP) is 265 times that of CO_2)
- Reduces nitrogen oxide (NO_x) emissions due to the higher volatility and lower fuel-bound nitrogen
- Improves combustion efficiency due to the higher volatility which results in better burn out and lower unburned carbon in the ash
- Reduces sulfur oxide (SO_2) emissions due to the lower sulfur content
- Reduces particulate emissions
- Reduces non-methane hydrocarbon emissions
- Reduces more GHG emissions from recycling aluminum, corrugated cardboard, newsprint, and fiber board recovered from the waste stream during ReEngineered Feedstock production than from source reduction of the same material mix due to the displacement of virgin materials used in manufacturing new materials
- Reduces methane (CH_4) emissions due to the avoided landfill decomposition of the solid waste constituents of the ReEngineered Feedstock (the capacity of CH_4 to contribute to the warming of the atmosphere, a measure known as the global warming potential (GWP) is 28 times that of CO_2)
- Reduces methane emissions released during surface coal mining operations
- Reduces the consumption of non-renewable resources such as coal
- Compliance option for cement plants under the California Cap-and-Trade Program for GHG emissions and other similar programs
- Total system energy efficiency increases as less coal is burned because of co-combustion and less upstream energy is required to produce and deliver ReEngineered Feedstock. Coal must also be mined and cleaned, requiring additional energy consumption

Environmental Matters and the Regulatory Benefits of Co-Firing ReEngineered Feedstock

Cement plants are subject to numerous federal, state and local laws and regulations pertaining to health, safety and the environment. As discussed below, some of these laws, such as the CAA, impose environmental permitting requirements and govern the nature and amount of emissions that may be generated when conducting particular operations.

- Regulation of GHG Emissions

Reducing GHG emissions can be challenging for cement plants, which likely are to be targeted for regulation because: (1) the cement manufacturing process requires the combustion of large amounts of fuel to generate very high kiln temperatures; and (2) the production of CO_2 is a byproduct of the calcination process, whereby CO_2 is removed from calcium carbonate to produce calcium oxide. For example, the California AB 32 Cap-and-Trade Program already requires California cement plants to obtain and retire carbon credits sufficient to cover their GHG emissions. Credits currently trade at over $13 per metric ton of CO_2e emitted and the California Air Resources Board recently has proposed increasing the compliance burden on cement plants post-2020 via reducing the allocation of free allowances by 26%. Notably, cement plants already possess a carbon pricing incentive to purchase ReEngineered Feedstock as such plants would be able to sell any freely allocated allowances that are surplus after accounting for ReEngineered Feedstock's lower carbon intensity. In other words, lowering a cement plant's compliance obligation before 2020 via use of ReEngineered Feedstock will generate immediate cost savings. ReEngineered Feedstock can substantially lower compliance costs for California cement plants by replacing carbon-intensive coal emissions as the biogenic portion of ReEngineered

Feedstock would qualify as a biomass-derived fuel that does not trigger a compliance obligation under the Cap-and-Trade Program.

Future GHG regulations likely will create opportunities for further cost savings via the use ReEngineered Feedstock. EPA eventually is expected to propose GHG emission performance standards for industrial sectors including cement manufacturing, as they have for electricity generation via the Clean Power Plan. States also may implement measures similar to California's Cap-and-Trade Program to regulate GHG emissions from industry, either individually or via linked, regional programs like the Western Climate Initiative. For example, both Washington State and Oregon currently are working toward such programs.

- Regulation of Criteria Pollutants

Another significant regulatory challenge for cement plants relates to EPA's promulgation of revised regulations for Commercial and Industrial Solid Waste Incineration (CISWI) units, pursuant to Section 129 of the CAA, which requires EPA to set emissions guidelines (EGs) for pollutants for certain non-hazardous solid waste incineration units. Affected sources must comply with the revised CISWI EGs by the earlier of 3 years from the date EPA approves a state plan implementing the CISWI EGs, or 5 years from the date of the final rule (i.e., by February 7, 2018).[5] As of the date of this white paper, EPA has not approved any state implementation plans, but did promulgate a federal implementation plan on December 14, 2016. By contrast, Section 112 of the CAA establishes a regulatory process for addressing emissions of hazardous air pollutants (HAP) from various categories of stationary sources. EPA recently finalized amendments to the National Emission Standards for Hazardous Air Pollutants for the Portland Cement Manufacturing Industry (PC NESHAP) under Section 112. Whether a cement manufacturing facility constitutes a CISWI unit regulated under Section 129 of the CAA or a cement kiln regulated under Section 112 of the CAA hinges on whether it combusts any "solid waste", as that term is defined under Subtitle D of the Resource Conservation and Recovery Act (RCRA). In 2013, EPA finalized the aforementioned NHSM rule in part to provide the definition of "solid waste" that is used to determine if a cement kiln is regulated under the CISWI EGs or the PC NESHAP. The NHSM rule lays out processing and legitimacy criteria that are used to determine if a non-traditional fuel is considered a solid waste. Combustion of a solid waste triggers applicability of the CISWI EGs.

ReEngineered Feedstock addresses several of the regulatory challenges discussed above by reducing CO_2 and other air pollutant emissions. Due to certain federal regulatory changes, the cost savings and regulatory benefits of co-firing ReEngineered Feedstock as part of an emissions compliance plan are increasing. Both cement kilns currently co-firing MSW and those burning exclusively coal can utilize ReEngineered Feedstock to lower their emissions and increase their cost savings, achieving a competitive advantage. Those cement kilns currently co-firing MSW may realize the largest benefits, because the switch to ReEngineered Feedstock (a non-waste fuel) will affect the regulatory framework that applies to that cement kiln. As described above, EPA has established two different sets of emissions requirements for cement kilns: (1) the PC NESHAP for kilns that do not burn solid waste; and (2) the CISWI EGs for kilns that burn solid waste. Historically, cement kilns burning MSW have received regulatory exemption from being considered CISWI units; such cement kilns were instead subject to the PC NESHAP and its predecessors.[6] However, the revised CISWI EGs effectively remove this exemption. Any cement kilns firing MSW (or any solid waste) after February 7, 2018 will be subject to the new CISWI EGs if they continue to combust any solid waste.[7] As the CISWI EGs have more stringent and/or different

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5 On July 29, 2016, the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) issued a decision on a consolidated legal challenge to three EPA rules, including the revised CISWI EGs. *See American Forest and Paper Association v. EPA*, 830 F.3d 579 (D.C. Cir. 2016). In its decision, the D.C. Circuit remanded to EPA certain provisions of the CISWI rule. Various parties to the proceeding petitioned for reconsideration, and the ultimate resolution is not yet known. However, the D.C. Circuit's decision does not appear likely to impact the provisions relevant to this white paper, or those to be implemented in the federal implementation plan promulgated by EPA on December 14, 2016.

6 40 C.F.R. § 60.32b(m).

7 Stated differently, the RCRA definition of "solid waste" is integral to defining the CISWI source category. Commercial and industrial units that combust solid waste are subject to the CISWI rule, rather than to standards issued pursuant to Section 112 of the CAA that otherwise would be applicable (e.g., the PC NESHAP applicable to cement kilns). So, cement kilns combusting solid waste, including MSW, are waste-burning kilns subject to the CISWI EGs, not the otherwise applicable PC NESHAP.

emissions requirements than the PC NESHAP, it will be beneficial for many cement kilns to avoid being considered a CISWI unit.

Cement kiln operators can avoid being classified as a CISWI unit by co-firing ReEngineered Feedstock instead of MSW, as ReEngineered Feedstock is not considered a waste for purposes of the CISWI EGs. In short, cement kilns cannot burn MSW after February 7, 2018 without being subject to the generally more onerous CISWI EGs, but they can switch to co-firing ReEngineered Feedstock instead of MSW to avoid this classification.

Accordant Energy, LLC has received a letter from EPA designating ReEngineered Feedstock as a non-waste fuel for purposes of the NHSM rule, which determines which non-hazardous secondary materials are, or are not, solid wastes when burned in combustion units for purposes of the CAA. As such, cement kilns co-firing ReEngineered Feedstock generally would be subject to the PC NESHAP rather than the CISWI EGs. While Accordant Energy, LLC's EPA letter examines combustion in coal-fired power plants and industrial boilers rather than cement kilns, the logic and analysis that EPA used in the letter also would apply to cement kilns designed to burn coal. The relevant analysis under the NHSM rule is identical. Indeed, EPA has undertaken an identical analysis as that found in Accordant's EPA letter in issuing other NHSM determination letters for the use of certain fuels in cement plants and kilns.[8]

Emissions Limits under the PC NESHAP and the CISWI EGs

The table below compares the current major source emission standards for cement kilns – both waste-burning and non-waste-burning – under normal operations. Using ReEngineered Feedstock and remaining subject to the PC NESHAP prevents kiln operators from being subject to stricter dioxin/furan, lead and cadmium emissions limits, among others, under the CISWI EGs.

Table 2 Major source emission standards for waste-burning and non-waste-burning kilns

Emission Type	Emission limits under the PC NESHAP for existing non-waste-burning cement kilns[9]	Emissions limits under the CISWI EGs for existing waste-burning cement kilns[10]
Particulate Matter (PM)	0.07 lb/ton clinker	13.5 mg/dscm
Dioxins/Furans (D/F)	0.2 ng/dscm (TEQ)	0.075 ng/dscm (TEQ)
Mercury (Hg)	55 lb/MM tons clinker	0.011 mg/dscm
Total Hydrocarbon (THC)	24 ppmvd	N/A (see carbon monoxide limit)
Hydrogen Chloride (HCl)	3 ppmvd	3 ppmvd
Nitrogen oxides (NO_x)	1.5 lb/tons clinker[11]	630 ppmvd
Sulfur Dioxide (SO_2)	0.4 lb/tons clinker[12]	600 ppmvd
Carbon Monoxide (CO)	N/A	110 (long kilns) / 790 (preheater/precalciner) ppmvd
Lead (Pb)	N/A	0.014 mg/dscm
Cadmium (Cd)	N/A	0.0014 mg/dscm

Note that some units are not equivalent, and an apples-to-apples comparison for each cement kiln

8 Letter from EPA to Entsorga WV LLC (Dec 9, 2013) (available at). ReEngineered Feedstock has significantly higher Btu/lb and lower sulfur, mercury, chlorine, fluorine, nitrogen and lead emissions than the product described in Entsorga's letter.

9 40 CFR § 63.1343 Table 1.

10 40 CFR Part 60 Subpart DDDD, Table 8.

11 40 CFR 60.62(a)(3), but applicable only if construction, reconstruction, or modification of the kiln commences after June 16, 2008.

12 40 CFR 60.62(a)(4), but applicable only if construction, reconstruction, or modification of the kiln commences after June 16, 2008.

configuration requires a detailed engineering analysis. For general indications of the difficulty of meeting the various standards, we refer you to an analysis conducted by the Portland Cement Association (PCA) on the proposed CISWI EGs.[13]

Please also note that we only have provided basic information with respect to emissions limitations for illustrative purposes, as there are numerous measurement qualifications and guidelines, as well as slight variations based on the years of construction for more recently constructed plants, in the final standards. Cement kilns also are subject to an array of additional federal, state, and local regulations that may change over time, and cement kiln owners and operators should receive counsel before making decisions that could affect regulatory compliance.

Costs of Emissions Controls and Compliance

The PCA Report found that for those facilities that currently were burning solid wastes at fractions above 1%, the cost for those plants to comply with the CISWI EGs would be an additional $2 billion beyond the estimated $3.4 billion to comply with the PC NESHAP.[14] Although under both scenarios the majority of facilities are required to install baghouses, significantly higher percentages of CISWI-regulated cement kilns will be required to install wet-scrubbers. Additionally, some CISWI units will be required to install selective non-catalytic reduction controls for NOx, and burner systems for carbon monoxide. Avoiding the installation of such additional devices where possible by co-firing ReEngineered Feedstock rather than MSW can provide cement kiln operators substantial savings, but a targeted emissions control systems profile likely is warranted to identify total cost savings. Additionally, the PCA Report noted that most sources would face incrementally higher costs by complying with the CISWI EGs compared with the PC NESHAP, but that CISWI units could experience potential fuel cost savings arising from alternative fuel usage.[15] By utilizing ReEngineered Feedstock, certain kiln operators can have their cake and eat it too – benefiting both from lower regulatory compliance costs and lower fuel costs.[16]

Conclusion

The energy and environmental benefits of using ReEngineered Feedstock as an alternative and renewable fuel in cement calciners and kiln burners are quantifiable and significant. The use of ReEngineered Feedstock significantly reduces CO_2 emissions at both the point of combustion and on a life-cycle basis. CO_2 reductions can be magnified in jurisdictions where policies are in place that, for example, recognize landfill methane emissions avoidance or categorize non-recycled materials as partially or entirely renewable due to the biogenic content of ReEngineered Feedstock. Additionally, lower sulfur dioxide (SO_2) emissions are expected from the displacement of coal.

In addition to the air emission benefits, the use of ReEngineered Feedstock as a renewable and alternative fuel reduces the amount of material that is disposed of in landfills, saving landfill space, extending the life of existing landfills and avoiding associated methane emissions from the biodegradation of landfilled waste.

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13 PCA, "Overview Impact of Existing and Proposed Regulatory Standards on Domestic Cement Capacity" 4 (January 2011) (estimates exclude those potential costs for closing plants) available at http://www2.cement.org/econ/pdf/ImpactEPARegs22011.pdf (hereinafter, "PCA Report").

14 *Id*.

15 *Id*. at 20.

16 In addition to emissions reductions and cost savings under federal regulations, co-firing ReEngineered Feedstock also may allow cement kilns to qualify for Renewable Energy Credits and certain tax incentives under state and local laws and regulations.