Of paper and polymer

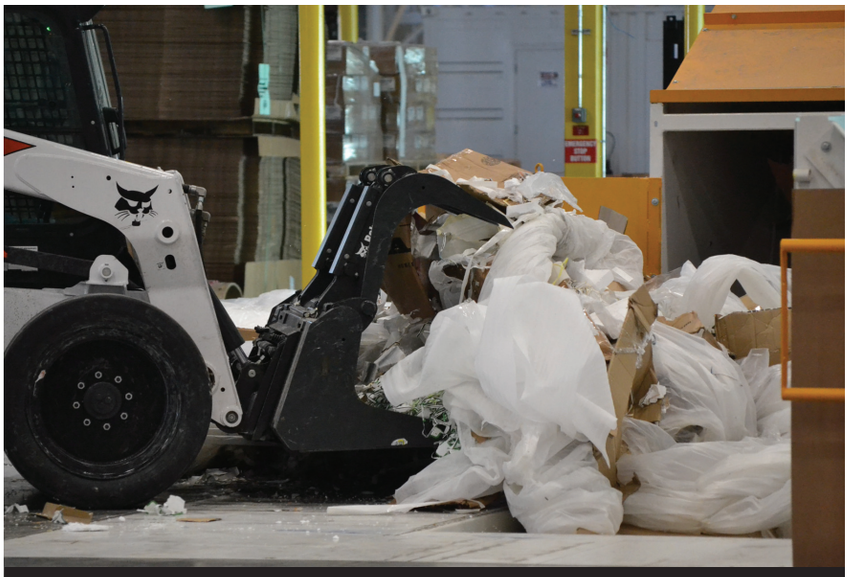
A wide range of alternative fuels (AFs) are available to the global cement industry and AF suppliers continue to develop new types geared specifically to energy-intensive industries (EIIs) such as the cement sector. In the US one AF producer has developed a solid fuel product from paper and polymer byproducts.

■ *by **Materials Lifecycle Management Co**, USA*

The impact of extracting and using coal and other fossil fuels in cement manufacturing is the subject of much legislation, policy development and decisions on project financing. In addition to the extensive energy conservation efforts undertaken by the cement industry itself, alternative fuel (AF) switching is part of the International Energy Agency's (IEA) Technology Roadmap Low-Carbon Transition in the Cement Industry and referenced as a carbon emissions reduction lever.[1]

Materials Lifecycle Management Co (MLMC) – based in Parker, Colorado, USA – is working at local, regional and federal levels to boost understanding and awareness for the critical need to capture high-energy, clean materials and direct them into a supply chain to manufacture a solid fuel that is not an opportunity or waste fuel but a commodity, similar to traditional fuels.

To support this new, viable supply chain, the company opened in March 2019 a new 200,000tpa fuel manufacturing facility in Plant City, Florida. At this new plant, locally-sourced raw material feedstock will be converted to a solid fuel that reduces the need to burn coal, heavy oil and other fossil fuels. Building on more than 20 years of experience, it aims to provide economic benefits to local and industrial suppliers while delivering a reliable AF supply to its customers, including the cement industry.



Paper and polymer byproducts form the raw materials for a new solid alternative fuel

Gaining recognition

The new fuel production facility is the latest in a series of milestones since the company's start-up in 1998. MLMC's predecessor began its journey in western Massachusetts where it specialised in sourcing non-recyclable papers and laminated films from local manufacturers to support its line of converting and mill broke business. Further processing of these materials also created a stream of paper and polymer byproducts that could be blended and densified into a solid fuel product, Enviro Fuel Cubes® (EFC) with characteristics that compared favourably to heavy fuels such as coal: no mercury, very low sulphur, high heating values and simple burning. EFCs are engineered mainly as a coal substitute to produce heat or steam as required in industrial manufacturing and utility power generation. They deliver a heat value of ~10,000Btu/lb with some variation (see below). Their high heat value, low moisture and other pre-engineered characteristics make EFCs a homogenous, simple-to-use fossil fuel substitute that provide many environmental benefits over coal.

As these were 'clean' materials and tightly controlled at the upstream manufacturing sources, the company began a multi-year journey to gain recognition as a fossil fuel substitute in energy-intensive industries (EII).

The goal was two-fold, first seeking to gain recognition as a non-waste fuel, as well as pursuing recognition under state renewable energy standards given the fuel product's composition (at least 75 per cent fibre). From the outset, it was an uphill struggle: byproducts such as these were still considered a waste and as such, any fuel product derived from them would be a waste fuel. In addition, incinerators did not want the fuel as its heat value was too high and MLMC was not in the business of paying to have its fuel burned.

Regardless, MLMC's team met with regulators and policy makers in its home state and over 20 other states where solid-fuel permitting rules existed. While many states were willing to work with MLMC, the lack of a clear non-waste fuel path at the federal level was a huge obstacle. The company finally gained recognition under the Massachusetts Alternative Energy Portfolio Standard, though opportunities for credit were not available.

Despite these challenges, MLMC successfully conducted over 19 AF trials in domestic cement kilns, power stations and paper mills. In one case, a kiln made

MLMC's EFC production line at the company's new facility in Plant City, Florida

a short-term, 100 per cent replacement of its coal with EFC at a feed rate of 14tph – at the time reportedly very rare.

Circumstances changed for MLMC in 2011. In one of the earliest determinations under the US EPA's non-hazardous secondary materials regulations (40 CFR 241.3), MLMC and its fuel product were given a clear path to enter the market and compete with traditional fuels, especially coal and heavy oil. The key points in the US EPA decision reflected MLMC's use of a selective raw material sourcing method and its manufacturing technology, which result in a fuel product with characteristics meeting or exceeding published data for Contaminant Concentrations in Traditional Fuels.[2]

Specific sourcing model

MLMC's sourcing model is based on the selection of high-energy, simple-burning and 'environmentally-clean' materials to manufacture MLMC's fuel product. Depending on the market, blending adjustments can yield a higher net fuel value (9000-11,000Btu/lb) or a higher net biomass content (at 85 per cent biomass, EFC yields over 8000Btu/lb).

The fuel's raw material is controllable and plentiful. However, despite common perception, not everything is recyclable as a function of market conditions. There has been much in the popular media recently indicating the global challenges to recycling and the virtual collapse of the market. Reports in the New York Times,[3] among others, cite challenges to the established recycling infrastructure in cities and towns with the result being that previously-recycled materials are now being landfilled. While much of the current concern regards post-consumer or municipal solid waste (MSW) streams, massive amounts of energy are also available in pre-consumer industrial and commercial sectors of interest to MLMC.

What makes materials non-recyclable is a combination of their construction and market economics. For instance, many materials are actually built from layers, or contain pigments and other enhancements, or may have been blended – all of which results in little to no recycling value.

These raw materials are good energy-dense fuel substrates. The energy value in non-recyclable plastics (NRP) is discussed in detail in many recent publications. The American Chemistry Council (ACC) sponsored a report by the Earth Engineering Center of the City College of New York (EEC CCNY) and found that "multi-layered flexible plastic packaging and laminates are well suited for energy recovery since most of their mass can be converted to useful energy. As plastics continue to displace other materials in a variety of applications, these findings are important for policymakers tasked with finding post-use solutions for non-recycled plastics as well as abundant, reliable sources of alternative energy."[4]

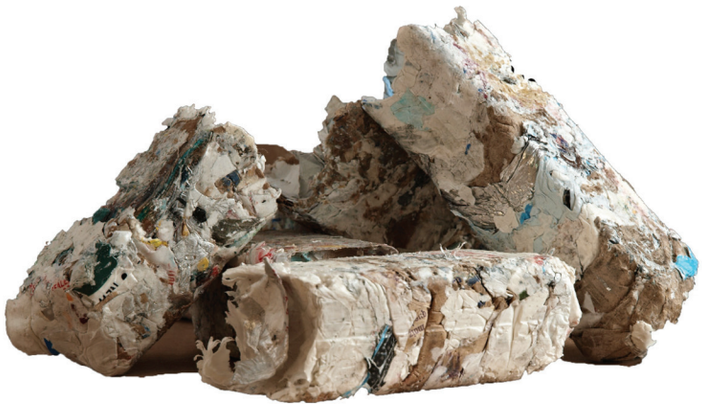
Quantity estimates are also reliable. Themelis and Mussche[5] cite: "The majority of NRP in the US, approximately 82.7 per cent (32.5Mt), is currently landfilled. This represents a loss of a valuable alternative energy resource. There is a significant opportunity to transform the abundant energy in NRP into electricity and heat and to commercialise new processes that produce higher value fuels and chemical feedstocks."

Sourced raw material awaits processing to EFCs

Ready to supply

Fuel costs are proportionate with coal and MLMC does not receive incentives or credits. While MLMC is watching the renewables and carbon policy horizon, its business stands on its own. As CEO and President, Todd Wenner, observed: "With MLMC, there's nothing to wait for

The finished fuel – Enviro Fuel Cubes® – ready for delivery to the customer



– as a manufacturing business we can be operational in several months, not years. We can operate in many markets, close to both our raw material supply and our fuel buyers. Our market model is designed to capture the energy in 400Mlb of non-recyclable material and turn it into a fuel product that can be used today to make cement. EFC is a locally-sourced fuel used to make a local infrastructure and building product."

Delivering EFCs

MLMC makes it easy for its offtake partners – fuel is delivered in standard freight quantities, usually by dry trailer. Utilisation costs are very low, as EFCs can be directly fed with traditional rotary airlock technology or injected co-tangentially with solid fuel using MLMC's proprietary EFC De-Densification and Delivery Unit® or DDU®. The DDU is a stand-alone unit capable of delivering 20tph of fuel using low-volume, high-pressure blowers. The DDU is controlled by kiln operators, and performance as reported in trials suggests that the fast burning nature of the EFCs allows for additional control to offset coal mix variability and dampness.

Sustainable partnership

MLMC's business is a true and sustainable partnership as it creates a new product from unwanted and unusable high-energy materials. The suppliers for MLMC's raw materials enter long-term supply agreements that allow MLMC to work on long-term fuel agreements with its cement industry partners. Thus, a circular economy is created. The well-being of each party is critical to the overall success of the relationship.

In addition, local social and economic benefits are both obvious and significant. In terms of local employment, MLMC's new facility in Plant City is on track to employ over 45 workers.

Furthermore, MLMC's business model takes unusable materials out of the commercial and industrial sectors at a lower cost than what is seen in either

Multi-layered plastics and laminates are well-suited to recycling

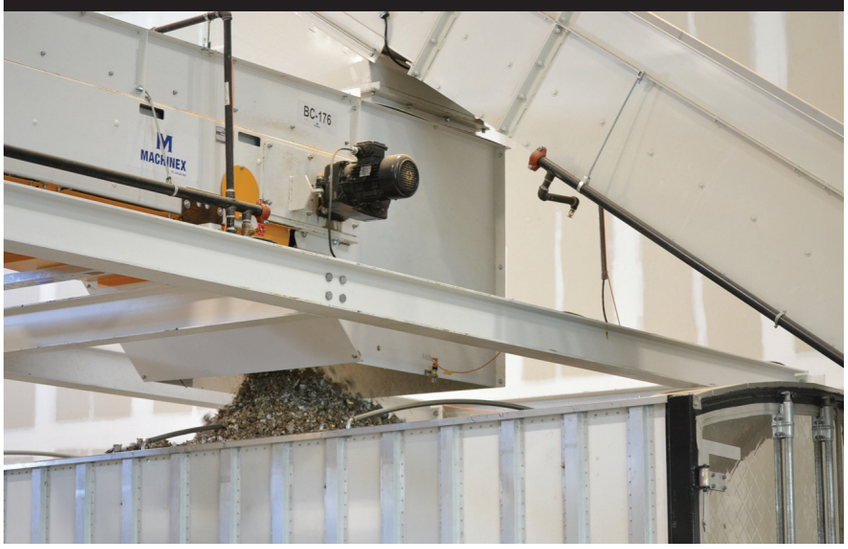
"Therefore, in addition to fossil fuel substitution and its benefits, MLMC's suppliers are partners in reducing the cement kilns' raw material needs."

waste-to-energy or landfilling. There are many efficiencies MLMC applies to make this happen – pricing incentives, long-term agreements, switching to larger containers and in-plant partnerships to safeguard feedstock integrity. As a result, many MLMC suppliers see solid waste reductions of as much as 80 per cent once the waste enters the MLMC supply chain.

Additional market opportunities also exist in MLMC's secondary lines of business. The majority of MLMC's effort is focussed on non-recyclable and low-market value materials. But, because of the amount of material MLMC accesses, recycling and re-use are options where market economics are favourable and reliable supplies can be developed. MLMC continuously monitors these markets to ensure sustainability in its business model.

Working with the cement industry is especially rewarding for MLMC and its suppliers. The company sees a local outlet for high-value fuel materials and a part of those materials (the ash) returns to the economy in the cement product itself. Therefore, in addition to fossil fuel substitution and its benefits, MLMC's suppliers are partners in reducing the cement kilns' raw material needs. ■

EFC is delivered to the customer in standard freight volumes, usually by dry trailer, which is loaded at the Plant City factory



Commercial EFC trials to achieve 100% fuel substitution in the cement industry

Of the many successful commercial trials completed using EFCs, one of the most significant was completed in a dry-process preheater cement kiln. This trial was conducted by firing EFCs directly into the burner zone using MLMC's patented fuel delivery system that delivers the fuel product into the burner independent of the kiln's primary fuel delivery equipment.

The cement company was expected to be able to achieve a 30 per cent coal substitution rate in the burner zone. However, by the middle of the first day of the trial, a 40 per cent coal substitution was achieved. This feed rate was maintained 24/7 for three days with results exceeding expectations. Therefore, on the fourth day, a ramp-up to a 60 per cent substitution rate was planned – previously considered unachievable without negatively affecting kiln conditions or product quality. However, the replacement of 60 per cent of coal with EFCs provided the results required.

Following a week in which the kiln was fired with a 60 per cent substitution of coal by EFCs, the plant manager authorised MLMC to increase the feed rate to 100 per cent. As the feed rate was gradually increased, the coal mill was eventually turned off completely and the kiln was fired entirely by EFCs at a rate of ~14tph.

Throughout the entire trial period, kiln conditions showed improved stability as the substitution rate of EFCs increased. Production and quality were unaffected and improvements in terms of plant emissions were reported. The overall trial consumed approximately 3000t of EFCs.

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