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Editorial

Dear Reader,

After two years of travel restrictions due to COVID-19, it seems that all postponed conferences and public events are taking place again now.

In-person events are genuinely irreplaceable, this year conferences and summits in our field of cement and alternative fuels have all taken place in Dubai, Barcelona, Antalya, K-Show Düsseldorf, Birmingham/AL, Amman, and Lisbon- just to name a few.

Individuals, companies, and equipment manufacturers are again on the move traveling from one conference to another. Humans all over the world catching up on their missed vacations and events, and bars and restaurants are crowded again despite the energy crises and inflation.

All airports are crowded and overwhelmed with the mass of people taking flights at some airports, such as Düsseldorf airport, people missed their flights as not enough security and staff people on-site to ensure safe boarding.

I am happy, that my conference program for this year ended, so I can concentrate on our ongoing alternative fuel projects in India, the Kingdom of Saudi Arabia, Lebanon, and Qatar.

When I am looking back, I must admit, that I really enjoyed the last two years at home- with less travel, and stress; but- honestly I am happy to be back on the road to meet my friends and colleagues from all over the world.

However we have learned, that many discussions can take place online which will lead us to reduce our travels only to the real necessary presence required.

I am not sure, if it is necessary to organise a climate conference with more than 30.000 people from all over the world flying into a desert with scarcity of water to promote their companies and green goals; I hope, that in such case they also learn to reduce their travels to the absolute minimum and rather have a virtual conference.

As the year ends, we always look back and for this year, it would be exactly 300 days of war between Russia and Ukraine, I like to look ahead and hope that this inhumane war finally ends.

In our present magazine we are – as usual- elucidating on the potential fossil CO_2 reduction projects, such as the use of sewage sludge as an alternative fuel in cement plants which can contribute significantly to the reduction of CO_2 emissions in cement plants and a case study on the use of biomass in cement plants. We also went further in this edition to describe the carbon market and how the cement industry can benefit from the carbon schemes.

Enjoy reading and think about your personal flight “CO_2” budget…

Dirk Lechtenberg
Managing Director
MVW Lechtenberg & Partner

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Alternative Fuels Sewage Sludge

The following article is a revised excerpt from the "Alternative Fuels and Raw Materials Handbook for the Cement and Lime Industry." – Vol. 1

By Dirk Lechtenberg, MVW Lechtenberg & Partner

The following article is a revised excerpt from MVW Lechtenberg & Partner's Alternative Fuels and Raw Materials Handbook, published in 2012. The handbook provides an insight into over 80 different types of alternative fuels and raw materials with detailed descriptions of the availability, common use, and practice in the cement industry. This includes processing considerations, the influence on the environment, clinker production, and the economics of the various alternative fuels.

Wastewater treatment plants for industrial or municipal wastewater all over the world produce residues, the so-called sludge, which is becoming more and more popular for the use as an alternative fuel in the cement industry. Since sludge is wet, waste heat from the clinker production process can be used to obtain dried sludge. This will have several environmentally friendly side effects:

- The use of waste heat
- Diversion of sludge from landfills
- Offering an environmentally friendly service to the public
- Saving fossil fuels
- Saving fossil CO_2 emissions
- Saving on costs

Sludge or slurry from the biological treatment (EWC number 190811*/12)

In biological treatment, the organic substances are reduced by microorganisms with the help of the metabolism process. The degradation process takes place in an aeration tank, where substrates are adsorbed first, and then due to microbiological activity water, CO_2, and new biomass are released. The raw sludge is removed by way of a settling tank and filtration. Thus, aerobic activity is maintained in a digester. The raw sludge has about 5% solid content and the stabilized sludge has 10%. The sludge will then be dewatered, for example by adding conditioning agents, and will then be mechanically dehydrated by a chamber filter press to a point where it possesses 30% to 40% dryness. Depending on the method of recovery or disposal it can be dried further by using thermal dryers. This sludge has a relatively high calorific value; the calorific value of dehydrated sludge may be greater than 11,000kJ/kg.

The consistency and composition of dehydrated sludge are similar to sewage slurry from treated municipal wastewater. The dry substance contains organic material (40-45% by weight) and minerals (55-60%) with reference to the initial composition including metals, metal compounds, petroleum hydrocarbons, and organic halogenated or non-halogenated pollutants. Sewage sludge is normally available in large amounts in municipal or industrial wastewater treatment plants. The diagram shows the annual amount of sewage sludge production and disposal activity in European countries in 2011 and 2018 [1]:

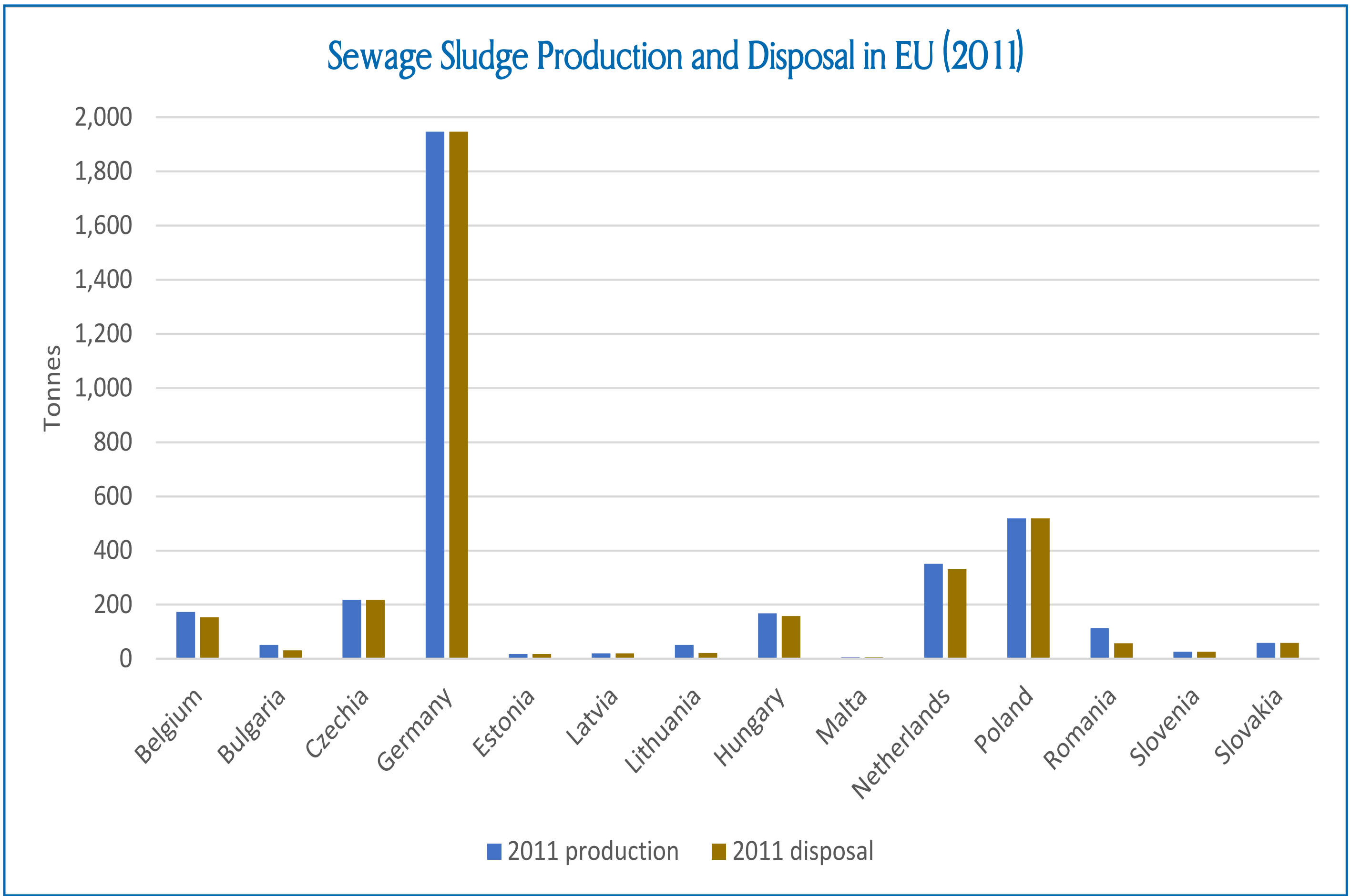

Figure 1: Production and disposal of sewage sludge in EU (2011) [1].

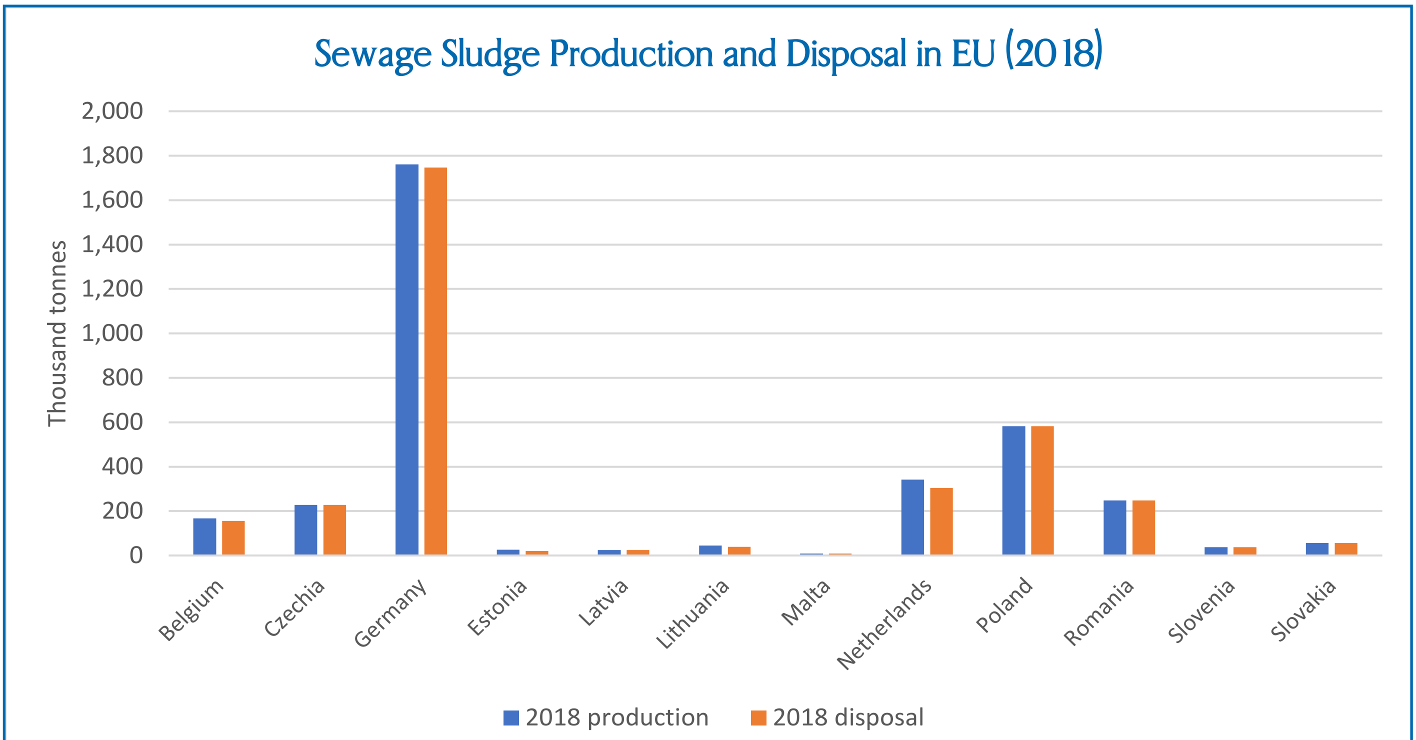

Figure 2: Production and disposal of sewage sludge in EU (2018 [1]).

In the Federal Republic of Germany about almost 1.8 million tonnes of sewage sludge every year is generated [1]. According to VDZ in 2020, 678,000 tonnes of dried sewage sludge were co-processed in German cement works [2]. The following table provides a compilation of dewatered and dried sewage sludges from different provenances:

Parameter	Unit	Sewage sludge*	Dried municipal sewage sludge**	Dried municipal sewage sludge ***	Dried sewage sludge****
Moisture	%	65 – 75	7.4	5	5.2
Calorific value	kcal/kg ar	n/a	3,320	2,500	n/a
Calorific value	kcal/kg dm	478 – 836	3,630	n/a	3,774
Volatiles	% ar	n/a	n/a	n/a	85
Ash	% dm	30 – 50	n/a	49 – 53	17.9
C	% dm	n/a	n/a	24.5	42.9
S	% dm	0.5 – 1.5	n/a	0.6	0.12
N	% dm	2 – 6	n/a	3.3	1.84
Cl	% dm	0.05 – 0.7	n/a	n/a	n/a
H	% dm	3 – 4	n/a	3.8	9
P	% dm	0.2 – 5.5	n/a	1.4	n/a
Pb	mg/kg dm	70 – 100	140	n/a	n/a
Cd	mg/kg dm	1.5 – 4.5	1.9	n/a	n/a
Hg	mg/kg dm	0.2 – 2	4.3	n/a	n/a
As	mg/kg dm	4.5 – 5	<5	n/a	n/a
Cr	mg/kg dm	50 – 70	460	n/a	n/a
Cu	mg/kg dm	300 – 350	350	n/a	n/a
Ni	mg/kg dm	30 – 35	71	n/a	n/a
Sb	mg/kg dm		<6	n/a	n/a
Zn	mg/kg dm	1,000 – 1,500	920	n/a	n/a
Grain size <10mm	%	n/a	n/a	95	n/a
Grain size <800µm	%	n/a	n/a	10	n/a
Note: ar = as received; dm = dry matter					

Table 1: Properties of different sewage sludges (Sources: * = [3] , ** = MVW, *** = [4], **** = [5])

The use of sewage sludge as an alternative fuel in clinker production is the most sustainable option. Due to the high temperature in the kiln, the organic content of the sewage sludge will be completely destroyed. The sludge minerals will be bound in the clinker after the burning process.

The usage of dried municipal sewage sludge in cement plants is common practice. Now, the usage of sewage sludge in cement kilns is increasing every year. In 2020 the quantity has more than doubled compared to 2010. [2].

The calorific value of sewage sludge depends on the organic content and on the moisture content of the sludge. Dried sewage sludges have calorific values of around 2,500 – 3,320kcal/kg. They are candidates for the substitution of fossil fuels as well as they serve also as raw materials owing to their high ash content.

Picture 1:Transport of dried sewage sludge by silo truck [6].

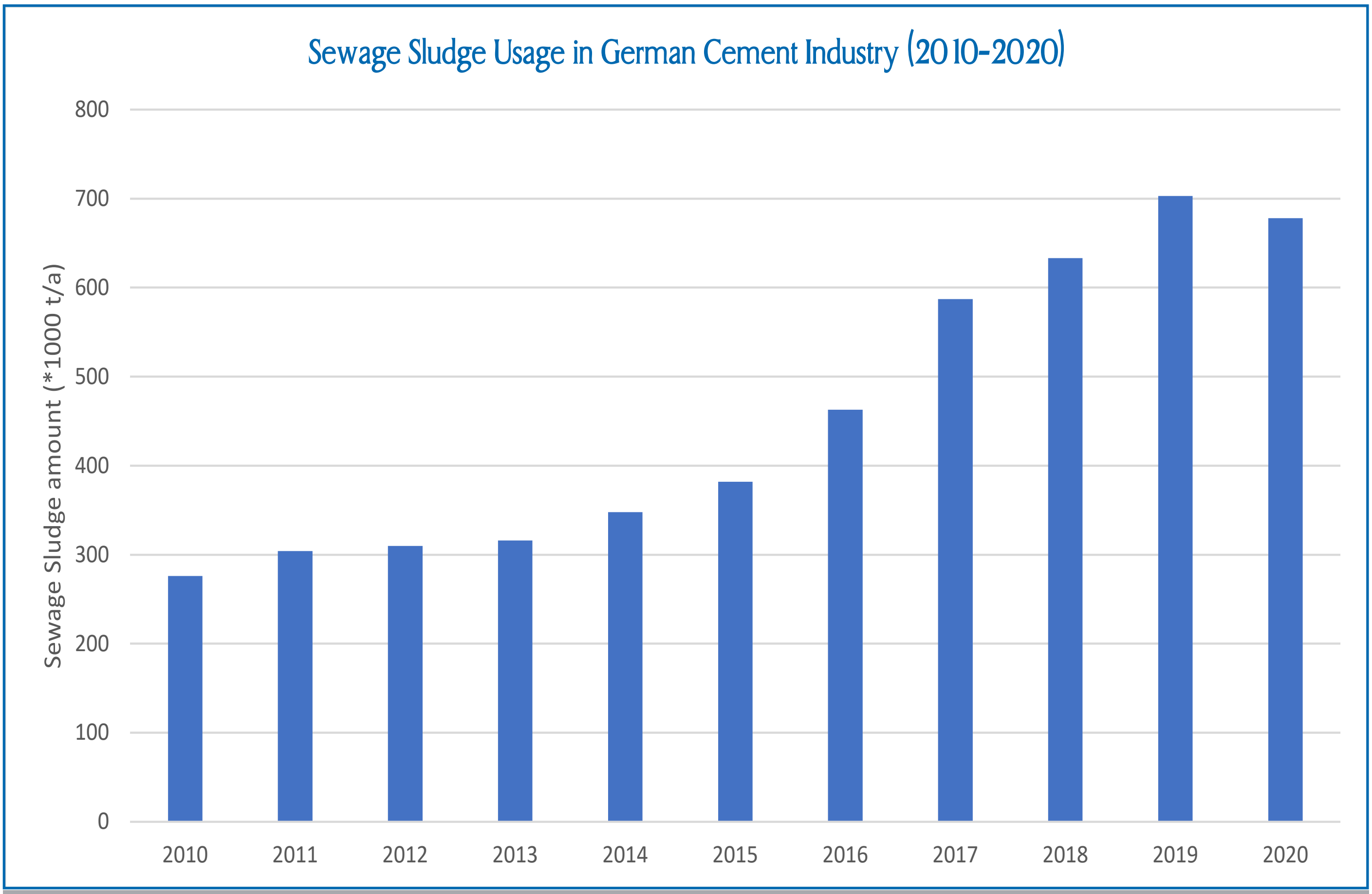

Figure 3: Sewage sludge disposal in German Cement Industry (2010-2020) [7].

The table below shows a calculation of potential savings by using sewage sludge, taking into consideration the calorific value in comparison with pet-coke and coal without any handling and operating costs and capital investment.

the sewage sludge can be taken fully into account. Referring to the substitution calculation above, the usage of 1.84 – 2.44 tonnes of dried sewage sludge save 1 tonne of coal which can be translated into savings of around 2.45 tonnes of fossil-derived CO_2.

Fuel substitution calculation

	Calorific value [kcal/kg]	Sub. factor CV coal	Sub. factor CV petcoke
Dried sewage sludge	2,500 – 3,320	2.44 – 1.84	3.24 – 2.44
Coal	6,100	1	*
Petcoke	8,200	*	1

Table 2: Fuel substitution calculation

However, even dried sewage sludges bear low energy content compared to coal. Sewage sludges can be used in combination with high calorific valuable fuels (e.g. coal, oils, solvents) which stabilise the exergy of the main burner flame.

Biomass CO_2 value

The dried municipal sewage sludge has organic material content (ca. 40 – 45 wt %). Therefore, the use of this alternative fuel in clinker production reduces fossil CO_2 emissions.

According to IPCC default of solid biomass fuel, the dried sewage sludge CO_2 emission factor is 110kg CO_2/GJ without consideration of biogenic content [8]. The municipal sewage sludge is considered to be fully biogenic, hence the "net" emission factor is zero [9]. The usage of municipal sewage sludge as fuel supports the saving of fossil fuel emissions.

If the municipal sewage sludge is dried with normally unused waste heat the ecologic CO_2 balance of

Quality influence on clinker

A research project of the German Cement Association [4] describes the quality influence on clinker while using municipal sewage sludge. The substitution of 10% of the heat demand by sewage sludges (around 1 to 4t/h of dried sewage sludge, and around 8t/h of mechanically dewatered sewage sludge) showed that the content of alite slightly decreased and the belite slightly increased. The influence on 28 days compressive strength did not follow a common trend. While the compressive strengths from plant 1 increased with sewage sludge, it was quite the opposite at plants 2 and 3.

Owing to the phosphorus content of municipal sewage sludges the influence on clinker can be significant. Experiences show an influence on increased setting times (approximately 20 – 30 minutes) and decreased 1- and 2-day (approximately minus 15%) compressive strengths when P_2O_5 in clinker is >0.8%.

	Unit	Plant 1			Plant 2		Plant 3	
		without sewage sludge	MEKS	TKS	without sewage sludge	TKS	without sewage sludge	TKS
C_3S	[%]	70.3	61.5	62.7	72	70.8	67.7	60.4
C_2S	[%]	8.3	16.2	15.8	13.2	13.9	18.6	25.7
Compr. strength 28 d	[MPa]	58.4	59.7	60.2	58.3	50.3	67.6	63.9
Compr. strength 90 d	[MPa]	61.3	63.4	65.8	66.2	66.1	75	69.7

Table 3: Results of sewage sludge usage in three German cement plants [10].

Investigations of [11] show the incorporation of P into C_3P-C_2S mixed clinker crystals which decrease the C_3S content and increase the free lime. With up to 1% P_2O_5 in clinker no negative influence on laboratory cement behaviour was detectable. The negative influence of phosphate in cement is dependent on the individual clinker composition and should be monitored thoroughly.

Recommendations

- Owing to the diverse origins of industrial wastewater, the sludge has a wide range of dangerous substances with different compositions. To assess the environmental relevance of the sludge, each case must therefore be considered.
- Especially the technical production aspects (procedures, materials used), the technical equipment and efficient working and operation of the wastewater treatment plant has to be considered.
- The composition of sewage sludge, among other things, is season dependent. In winter time, due to the high levels of de-icing salt used for street de-icing, the composition of sewage sludge varies.

By and large, the disposal of municipal sewage sludge in a cement kiln means that [4]:

- Around 50% organic matter substitutes the corresponding amount of fossil fuels
- Around 50% inorganic matter substitutes natural raw materials
- 100% of the sewage sludge is being disposed of without production of any ashes or slags
- The energy from organic matter is mostly neutral in terms of fossil CO_2 emissions

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Carbon Market: How the Cement Industry Can Benefit from the Carbon Credit Scheme

By Kudus Adebayo, MVW Lechtenberg & Partner

Summary

The concept of carbon credits or carbon trading was first mentioned and formalized on 10th December 1997 during the United Nations Framework Convention on Climate Change (UNFCC) conference held in Kyoto, Japan. This conference led to the adoption of the Kyoto Protocol, which aims to limit the emission of greenhouse gases (GHGs) by participating countries. In 2005 the protocol came into effect and has been declared to be an internationally binding agreement by all 192 participants [2]. The protocol takes into effect many considerations and objectives as well as individual actions applicable to all participants.

The concept has recently gained more popularity among investment professionals in climate change, leading to new business ideas and investment portfolios such that small and big corporations are now trading carbon.

Despite the recent developments, the majority of people still do not understand what it means and how it can benefit their industry. In this article, I will try to explain the carbon credit concept and how cement plants can benefit from the scheme.

A carbon credit is defined as “a tradable permit or certificate that provides the holder of the credit the right to emit one ton of carbon dioxide (CO_2) or an equivalent of another greenhouse gas. It is essentially an offset for producers of such gases” [3].

In the carbon market, technologies that reduce the amount of carbon an organization/company produces will generate unit value called carbon credits. A more practical definition can be derived from figure 1 below. Take organization A and organization B as carbon emitters with the same carbon emission cap (A maximum amount of GHG emission allowance per the Kyoto agreements to participating countries).

Organisation A’s emissions level falls below the carbon emission cap maybe by using more environmentally friendly methods and technologies for their production and as a result, gets a surplus depicted by the carbon credit awarded arrow. organization B, however, has exceeded its emission cap and as a result, would need to offset its excess carbon emission, to do this, both organizations could make a trade where organization A sells its available carbon credit to offsets organization B excesses. The total emission of both organizations must be within the agreed emission allowance [1]

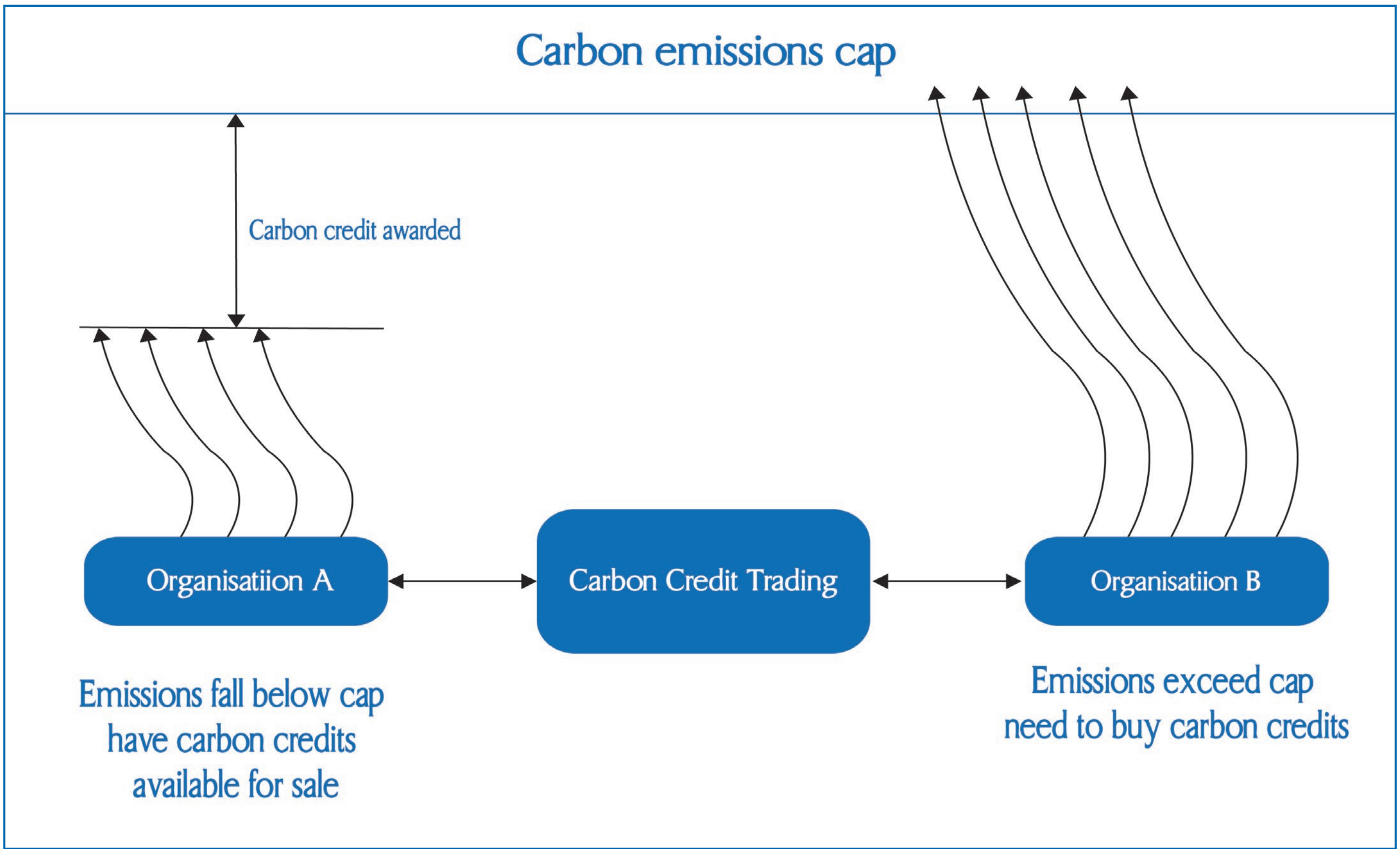

Figure 1: Practical illustration of the carbon market [1]

The above illustration in figure 1 is a simple illustration of how the carbon trading market works, however, there are more segments to the carbon trading market which include the types of markets and how carbon is traded. This segment will be covered in further sections of this article.

Considering how energy-intensive it is for cement manufacturing and the amount of CO_2 emission it contributes to overall GHG emissions in the world, the questions come to my mind, why are cement producers not considering substituting fossil fuel in their current production process which generates a high CO_2 emission with alternative fuels?. From an economic of point of view, cement plants have to pay high amount of fees for their emissions and as such a multiplier effect take place which will increase the prices of cement.

In this article, I will try to explain the background of carbon credits and how cement plants can benefit from the scheme.

The Kyoto protocols explained

The Kyoto Protocol was an agreement with the primary purpose to mitigate the emission of GHG by registered participants [4]. This agreement has created several other opportunities within the framework; an example is carbon credit.

The protocol listed six GHG causing adverse effects on the environment which are; carbon dioxide CO_2, methane (CH_4), nitrogen oxide (N_20), hydrofluorocarbons (HFC), sulfur hexafluoride (SF_6), and perfluorocarbon (PFC). These GHGs are measured on basis of a baseline scenario i.e., “a scenario that describes future greenhouse-gas emission levels in the absence of future, additional mitigation efforts and policies" All six GHG are converted into Certified Emission Reduction (CER) where a unit of CER is equal to 1 tonne of CO_2 equivalent (CO_2e) [1].

The Kyoto protocol established three (3) mechanisms that could aid the objectives of the agreement which include;

1. The clean development mechanism (CDM)
2. Joint implementation
3. Emission trading mechanism

1. The CDM mechanism can be described as a form of a developmental mechanism involving high income countries and ermeging and low income countries under the Kyoto agreement [5]. The mechanism allows a country within a defined emission limitation to implement or develop an emission reduction project in a low income or emerging county, which will lead to earning the CER credits equivalent to one tonne of CO_2. Under the Kyoto agreement, the high income countries' emissions were capped while the emission of low incomes countries were not capped, but kept under the CDM to stimulate the development and financing of new projects in low income countries [2].

The CER credits acquired could serve as an offset to exceeding carbon emission limits, and as result contribute to the carbon emission objective of the Kyoto agreement, and economic or social development to the emerging or low income countries depending on the project overtaken or traded to other participants who have exceeded their limits achieving the same overall objective of the agreement.

The mechanism is the first of its kind in environmental investment credit schemes as it provides a standardized emission offset instrument, and is regulated and overseen by the CDM Executives Board answerable to all participants of the Kyoto agreement [6]. It is also worth knowing that every CDM projects have to go through a rigorous check and be certified to provide emission reductions that are additional to what would have occurred.

2. The joint implementation can also be regarded as a project-based mechanism and second to the CDM, but differs in terms of activities as the joint implementation allows high income countries to carry out emissions reduction or removal enhancement projects in other high income countries [7].

3. The emission trading mechanism of the Kyoto protocol when put directly simply means GHG emissions are new commodities that can be traded. The emission trading mechanism was part of the agreement in such a way that, participants agreed on targets for limiting/reducing their emissions. The targets are expressed as levels of allowed emissions or assigned over a commitment period of 2008 – 2012 [3].

The allowed emissions are divided into assigned amounts units (AAUs) [1]. Typically, under the Kyoto protocol, all parties will have a national authority responsible for the allocation of carbon emission caps/limits per sector of the economy and then further distributed to businesses/companies.

The Kyoto protocol allows countries that have emission unit to spare i.e., emissions permitted but not used to be sold leading to the commercialization of carbon, which is otherwise called the carbon market.

Regulatory conditions are also in place to monitor the emission trading transactions, for example, to track the transfers and acquisitions of units, there is a registry system where transactions are recorded. Also, in a bid to ensure compliance and avoid overselling units by organizations in a country, that may lead to organizations not being able to meet their own emission targets, each party is mandated to maintain a reserve of emission reduction unit (ERUs,) such as the CERs, and AAUs in their respective national registry.

In conclusion, the Kyoto protocol was less effective leading to a major collapse of the protocol and research shows that it has further increased CO_2 emission by 600 million metric tons due to concern over environmental efficacy, corruption, and the fear that the projects were not successful in reducing emissions as presented to be. This led to the U.S leaving the Kyoto protocol in 2001 while the EU in 2012 stopped member states from buying the credits. However, there have been several other agreements developed after the Kyoto protocol with a much-improved regulatory framework and operating manual.

Although the Kyoto Protocol lost credibility, but also served as a backbone to new climate policies such as the Paris Agreement which adopted the mechanism of the Kyoto protocol replacing the CDM and JI with SDM (Sustainable Development Mechanism), and the EU Green Deal.

Carbon markets

There have been several discussions and arguments on the best practices to reduce GHG. Despite a series of institutional agreements and national and international policies, the current path to achieving a 1.50 – 2^0 climate temperature goal is promising, however, there are still more actions to be taken as many countries have to deliver on their promises to achieve the desired goals before the year 2030 which is only 8 years away [5].

The carbon market is part of many policies for emission reduction, and at the heart of a carbon market is the idea that putting a price on CO_2e emissions is a good idea as it represents the costs of emissions that the public pays for activities which as a result leads to damage of crops, health care cost from heat waves and droughts, and loss of properties from flooding and sea level rise [8]. These negative impacts led to a desire for a net zero world in which GHGs emitted are cancelled out by those removed from the atmosphere by putting a price on the numbers of emissions and such leading to a significant expansion of the global carbon market.

A price on carbon emission will help to shift the burden of the damages caused by the emission of GHGs back to those who are responsible for it and who can avoid it [8]. The idea is simply clear and practical, as the carbon price gives an economic signal to emitters with options to either transform their activities with more environmental friendly technologies in order to lower their emissions, or continue to emit and pay for their emissions, in this way, the overall environmental goal can be achieved [8]. This can be argued however, many environmental economists would support this argument with the idea that a price on environmental pollution made a significant contribution towards reducing environmental degradation and externalities involved in pollution.

There are two major types of carbon market namely the compliance carbon market or mandatory market and voluntary market. The compliance market is mostly used by the government and companies who are obliged by law to account for their GHG emissions. It is regulated by the national, regional, or international regulatory body. As for the voluntary market is simply based on voluntarily offsetting emitted carbons and it is used by governments, NGOs, universities, municipalities, and individuals. Currently, the majority of voluntary carbon credit (VCCs) is purchased by the private sector on corporate social responsibility basis (CSR) [9].

Many companies around the world take advantage of the VCCs sold by the registries (primary market) or enter into a voluntary carbon credit derivatives contract (secondary market) such as the future market. The primary and secondary markets are different in their operations and functions. The primary market involves the distribution of carbon allowance to: (i) participants in the compliance carbon schemes that must comply with an ETS and (ii) participants in compliance and the voluntary market that purchase carbon credit generated by emission reduction projects. The secondary market, however involves all subsequent trading of emission allowances and offset credits where market participants can trade spot and derivatives contracts based on allowances and offsets [9].

The regulations of both compliance and the voluntary market are different, and in fact the voluntary market has drawn a lot of criticism for not being regulated and operating based on trust that carbon emission projects have environmental integrity, and that the credit on the market truly contributes to reducing emission [10].

Several emission trading systems in the world are linked together and facilitate international carbon trading among companies with the primary purpose of reducing GHGs emissions. In the United States, the compliance market exists at the state and regional levels and an example of a trading system is the Regional Greenhouse Gas Initiatives (RGGI) which was the first cap and trade program in the US in 2005, while the California Cap and Trade Program (CCaTP) was launched in 2013 [9].

The EU Emissions Trading System (EU-ETS) is an example of an emission trading system and was set up in 2005. It is the biggest carbon emission market and also the world's first major carbon market. It operates in all EU countries plus Iceland, Liechtenstein, and Norway (EEA-EFTA states) and it has limited emissions from around 10,000 installations in the power sector and manufacturing industry, as well as airlines operating between these countries. The EU-ETS covers and focuses on sectors/industries where emissions can be measured, reported, and verified with a high level of accuracy which includes, cement, steel works, pulp, paper, bulk organic chemicals, etc, and participation in the EU-ETS is mandatory for the companies in these sectors [11].

The EU-ETS works on a cap-and-trade system as well and is linked with other international cap-and-trade systems such as in Canada. China, Japan, New Zealand, South Korea, Switzerland, and the United States as described in the joint implementation mechanism, but with specified conditions for sake of monitoring and regulations [11]. The caps decrease gradually in order to achieve emission reduction over time. The EU-ETS is currently worth 683 billion euros which is approximately $769 billion while the global market value of carbon trading is said to be around $851 billion in the year 2021 [12].

In summary, the carbon markets are a real emission abatement instrument that can deliver the desired goals of net zero emissions, but only when rules are clearly defined and designed to ensure transactions truly reflect reductions in emissions as this is a major setback of the concept in some participating country, however, there have been progress as well in these aspects as tools are available to calculate the actual emission reduction of projects and technologies.

CO_2 emissions and climate change

The science behind the objectives to limit GHGs emissions is clear as climate change is dominantly caused by the emission of GHGs to the atmosphere, although the atmosphere is composed of many gases, however, CO_2 can be regarded as the main driver of climate change [13].

combustion and industrial processes reached their highest ever annual level in 2021. A 6% increase was actualized, pushing emissions level to 36.3 gigatonnes (Gt). The increase in energy demand in 2021 was compounded by adverse weather and energy market condition leading to more coal being burnt and emissions increased by over 2.0 Gt from 2020 levels making 2021 the largest ever year-on-year increase in energy related CO_2 emissions in absolute terms [14]. Figure 3 shows the trend in emissions from 1900-2021.

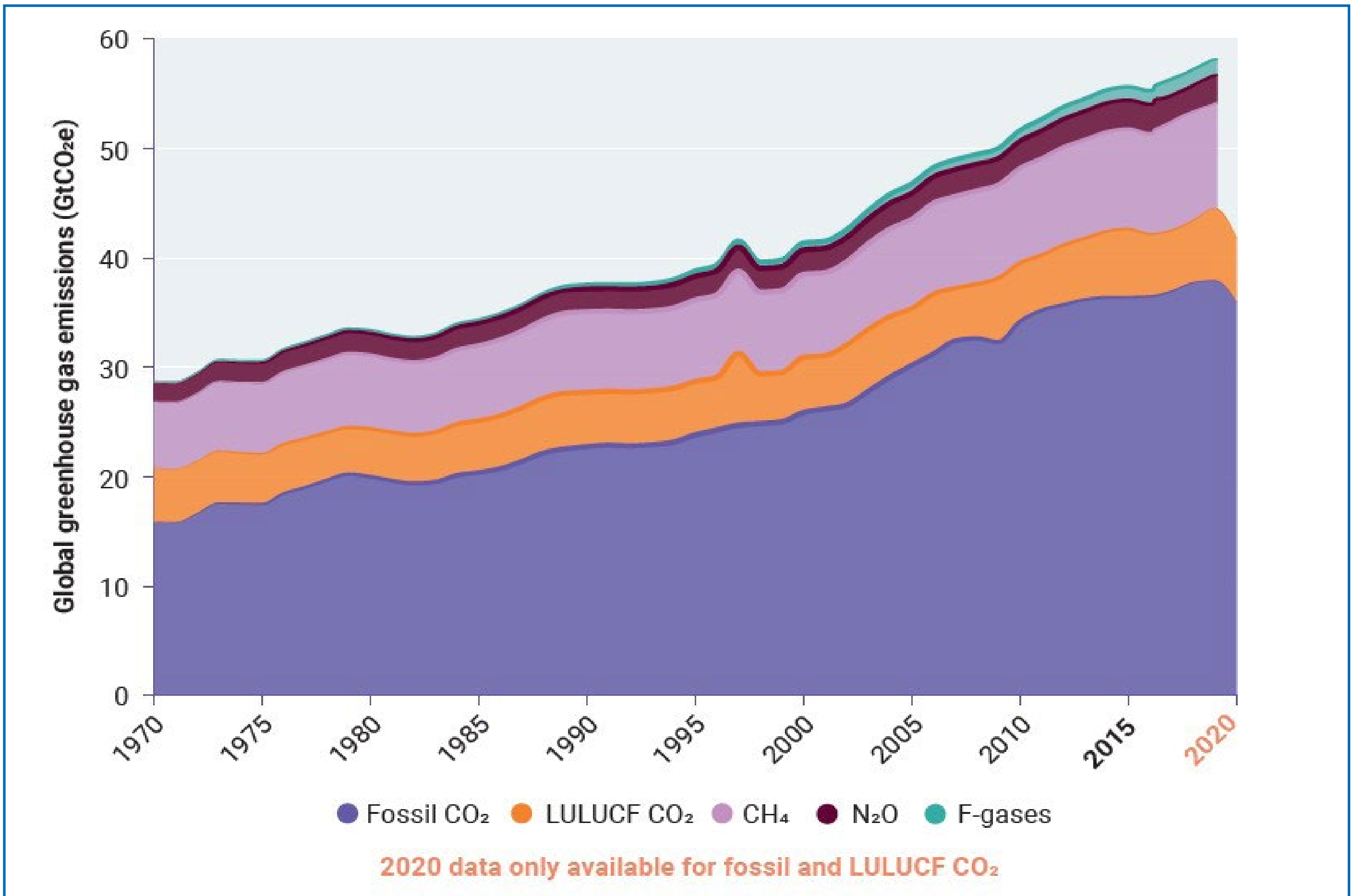

Figure 2: Global greenhouse gas emission from all sources, 1970-2020 [5]

Figure 2 above shows the development of GHGs emissions from 1970-2020. There was a drop of about 5.4% in global fossil carbon dioxide emission in 2020 which was due to the COVID-19 pandemic [5], however global CO_2 emissions from energy

CO_2 is the largest among other GHG being emitted and it has been the most debated among the others. Several industries around the world are concerned about their CO_2 emissions while also certain individuals tend to take the moral responsibility to consider the environment, and as such decided to take actions towards reducing their CO_2 footprints to the extent of also committing to voluntary carbon market or contributing to sustainability projects. As already explained in the previous section GHGs are measured and converted into CER where a unit is equal to 1 tonne of CO_2 equivalent. In connection to a carbon credit, a single carbon credit equals 1 tonne of CO_2 emitted or to be emitted.

that cement production is energy intensive and belongs among the highest emitters of CO_2, however, practical production processes which can reduce or mitigate CO_2 emissions in the process are being developed and recently, cement producers are puttinr resources towards the achievement of the net-zero plan of 2030.

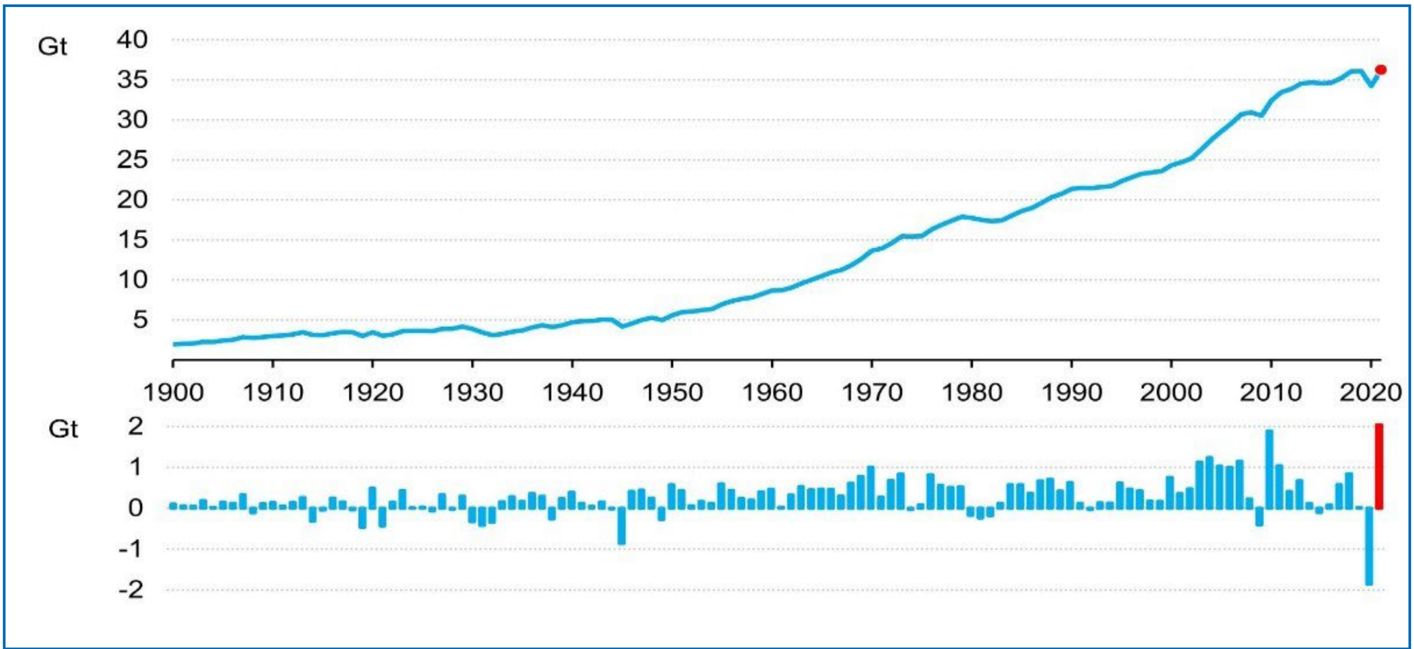

Figure 3: Total CO_2 emissions from fuel combustion and industrial process and their annual change, 1900-2021 [14]

The carbon market would serve all individuals if practiced efficiently as it leads to companies and government being sustainable which will ultimately reflect in the action of an average human being as for instance if the cloths and materials are actually sustainable and not just some marketing phrase, or if the food has been processed sustainably and every other product being produced including building materials such as cements. What I mean by being suitable is, when new technologies have been employed in production process or carbon offset are being bought and developed which are truly accounted for and captures the exceeded caps on the production activities.

For cement production, it is an established fact

The use of refused derived fuels is an alternative fuel which has significant advantage to cement production in liming CO_2 emissions but also serve the society. The use of alternative fuel for cement plants have also been supported by governments in some developing countries and also in some advanced countries like Europe, it is an already established procedure. More explanation will be given in the next section about the cement industry and CO_2 emissions.

The overall objectives of all established emission reduction principles, agreements, laws and actions are the same which is to reduce carbon emissions and also increase project development in removals of emissions and as such achieve what is termed "the net-zero targets". Reaching net zero CO_2 emissions results in CO_2 concentrations gradually declining over time towards a long-term equilibrium, as part of the excess CO_2 in the atmosphere is redistributed by the uptake in the biosphere on land and the ocean, and as result, CO_2-induced temperature is stabilized [5].

CO_2 emissions in the cement industry

Global production of cement has grown very rapidly in recent years, and after fossil fuels and land-use change, it is the third-largest source of anthropogenic emissions of carbon dioxide [15].

There are two aspects of cement production that result in emissions of CO_2. The first aspect is the chemical reaction involved in the production of the main component of raw materials for clinker, as carbonates (largely limestone, $CaCO_3$) are decomposed into oxides (largely lime, CaO) and CO_2 by heat. Stoichiometry directly indicates how much CO_2 is released for a given amount of CaO produced: one tonne of pure limestone releases 440 kg of CO_2, and 560 kg of CaO, or, when referred to one tonne of CaO, 785 kg of CO_2 is being emitted. These are process-related emissions and cannot be mitigated.

The second source of emissions is from the combustion of fossil fuels to generate the energy required to heat the raw materials to well above 1450°C, and these 'energy' emissions, including those from purchased electricity, could add a further 60% to top of the process emissions [15].

According to a think tank's report [16] "globally, the manufacture of cement produces more greenhouse gas emissions than any other single product – about 3 billion tonnes per year, or 8% of the world total". However, let's see what the cement industry can do immediately to reduce fossil-derived carbon emissions. Currently, worldwide clinker production capacity counts around 4 billion tonnes of clinker per year.

China produces the most cement globally by a large margin, at an estimated 2.2 billion metric tonnes in 2020, followed by India at 340 million metric tonnes in the same year. China currently produces over half of the world's cement. Global cement production is expected to increase from 3.27 billion metric tonnes in 2010 to 4.83 billion metric tonnes in 2030 [17].

The use of alternative fuels or waste-derived fuels is "best practice" in the cement industry, as basically, characteristics of the clinker burning process itself allow environmentally beneficial waste-to-energy and material recycling applications. The essential process characteristics for the use of waste can be summarised as follows [18]:

- Maximum temperatures of approx. 2000°C (main firing system, flame temperature) in rotary kilns
- Gas retention times of about 8 seconds at temperatures above 1200°C in rotary kilns
- Material temperatures of about 1450°C in the sintering zone of the rotary kiln
- Oxidising gas atmosphere in the rotary kiln
- Gas retention time in the secondary firing system of more than 2 seconds at temperatures above 850°C; in the precalciner, the retention times are correspondingly longer and temperatures are higher
- Solid's temperatures of 850°C in the secondary firing system and/or the calciner
- Uniform burnout conditions for load fluctuations due to the high temperatures at sufficiently long retention times

- Destruction of any organic pollutants due to the high temperatures at sufficiently long retention times
- Sorption of gaseous components like HF, HCl, and SO_2 on alkaline reactants
- High retention capacity for particle-bound heavy metals
- Short retention times of exhaust gases in the temperature range are known to lead to 'denovo-synthesis' of PCDD/F
- Complete utilization of fuel ashes as clinker components and hence, simultaneous material recycling (e.g., also as a component of the raw material) and energy recovery
- Product-specific wastes are not generated due to a complete material utilization into the clinker matrix; however, some cement plants in Europe dispose of bypass dust
- Chemical-mineralogical incorporation of non-volatile heavy metals into the clinker matrix

Technical analysis - cement plants and carbon credit schemes

The cement industry can be benefit from carbon scheme by employing more sustainable procedures in the cement production which could also mean by substituting the use of fossil fuels with alternative fuels. Recently, the global cement and concrete associations (GCCA) reiterated their desire to achieve a net zero emission in 2050 which also includes a milestone commitment to cut CO_2 emission by 2030 [19]. The road map aims to reduce a total of 5 billion tonnes of CO_2 emissions between 2021 and 2030. In the 7 points plan to achieve the net zero emission of concrete is the use of alternative fuels which is estimated to cover 22% of global cement kiln energy usage by 2030 [19].

Typically, a substitution rate of 80% can be achieved with the use of alternative fuels which will mean a significant amount of CO_2 emissions is reduced, and as a results carbon credit surplus can be achieved depending on assigned emissions caps which can be sold and then the proceeds reinvested in the production process or serves as earning to the cement plants.

Let's take a more technical and practical example. Let's assume all cement plants in the world would start using alternative fuels. Applying best practices, a thermal substitution rate of 60% can be achieved. If suitable wastes are available, this would be a realistic scenario to reach a 60% substitution rate. A typical RDF has a calorific value of min. 4500 kcal/kg . Typical average energy consumption is assumed with 800 kcal/kg clinker. Of course, modern kilns have a much lower energy consumption, but considering also old kilns, 800 kcal/kg seems to be a realistic number. Let's assume further, that all kilns are fired with coal with an average calorific value of 6400 kcal/kg. Although many kilns are fired with heavy fuel oil, natural gas, pet coke, etc., however, clinker production widely relies still on coal. With currently 4 billion tonnes of clinker production capacity, a quantity of 500 million tonnes of coal would be required.

If we reach a substitution rate of 60%, we will be environmentally friendly by treating more than 426 million tonnes of waste-derived fuels (RDF) and saving around 300 million tonnes of coal per year. The effect on the fossil CO_2 emission reduction would be tremendous: owing to its biogenic content of around 40%, RDF would save around 249 million tonnes of fossil CO_2 emission every year. In comparison to the set target of 5 billion tonnes in 2030 which 40% of the target can be achieved by only increasing the substitution rate to 60% as around 2 billion tonnes of CO_2 emissions will be reduced.

This points to the importance of alternative fuels if the net emission targets of 2030 and 2050 are to be achieved as with the contribution of other the other 6 actions in the road map, I am convinced that it can be achieved. Table 1 and Figure 4 show a clearer understanding to the reduction of fossil CO_2 emissions.

Is not sustainable to the overall value chain of cements, and as such could also have a spill over effect to other industries from an economic point of view.

Figure 5 shows the potential revenue from CO_2 emission trading by the cement industries. We have calculated the "value" of such carbon removal certificates based on the current European ETS Certificate value of 86.53$/tonne of CO_2 emissions. The next figure shows the impressive result:

Coal			RDF		
NCV	6,400	kcal/kg	NCV	4.500	kcal/kg
Emission factor	96	t CO_2 / TJ	Emission factor	65	t CO_2 / TJ
(default IPCC)	2.57	t CO_2 / t gas	(around 40% biogen share)	1.22	t CO_2 / t RDF
		Scenarios			
		0	I	II	III
		Baseline: Coal	20% substitution	40% substitution	60% substitution
Coal	[t/a]	500,000,000	400,000,000	300,000,000	200,000,000
Emission CO_2 from gas	[tCO_2/a]	1,286,184,960	1,028,947,968	771,710,976	514,473,984
RDF	[t/a]	0	142,222,222	284,444,444	426,666,667
Emission CO_2 from RDF	[tCO_2/a]		174,170,880	348,341,760	522,512,640
Total CO_2 emissions	[tCO_2/a]	1,286,184,960	1,203,118,848	1,120,052,736	1,036,986,624
Difference to baseline	[tCO_2/a]		83,066,112	166,132,224	249,198,336
	[%]		6%	13%	19%

Table 1: Substitution of coal by RDF, and resulting fossil CO_2 emission scenarios with 20%, 40%, and 60% substitution rates.

Coming back to the question from the beginning of this article: why is the cement industry not implementing such a realistic and easy-to-establish strategy for the reduction of their CO_2 emissions?

Fossil CO_2 emissions are expensive and, a further increase in the price for CO_2 emissions is expected considering the constant trend in the increase over the years,which means that cement producers will continue to pay higher fees for their emissions which

With a current certificate price of 86.53$/tonne of avoided fossil CO_2 emission [20], the cement industry would save around 21 billion Dollars per year when trading their CERs. This should be sufficient to finance all needed processing, storage, dosing, and feeding systems in the cement plants in connection with RDF as well as earning investment returns by participating in the carbon market by selling carbon offsets to other high energy intensive industry which in the end would benefits not only the cements industries but also the global environment.

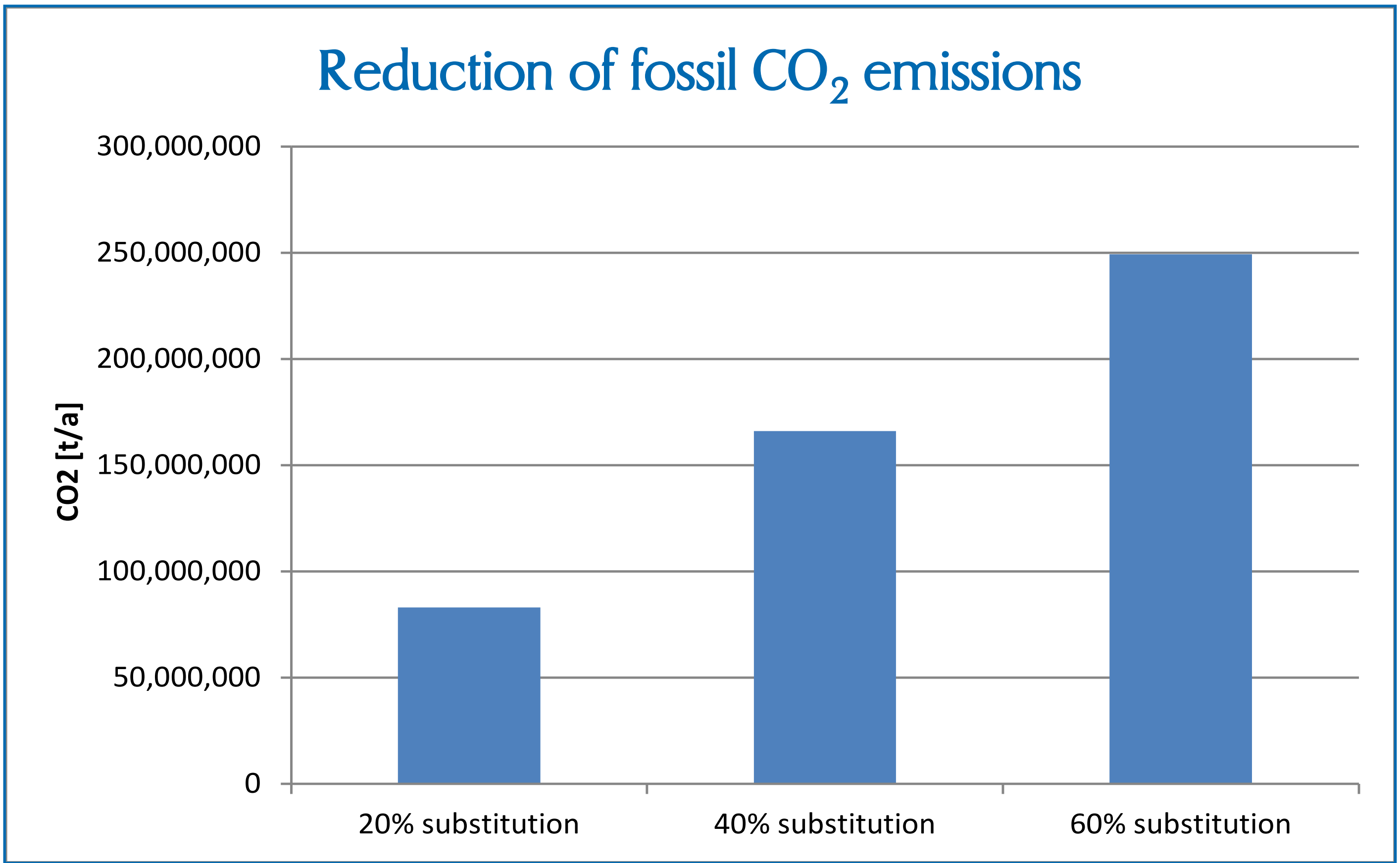

Figure 4: Reduction of fossil-derived carbon dioxide emissions from the global cement industry by substituting coal with RDF.

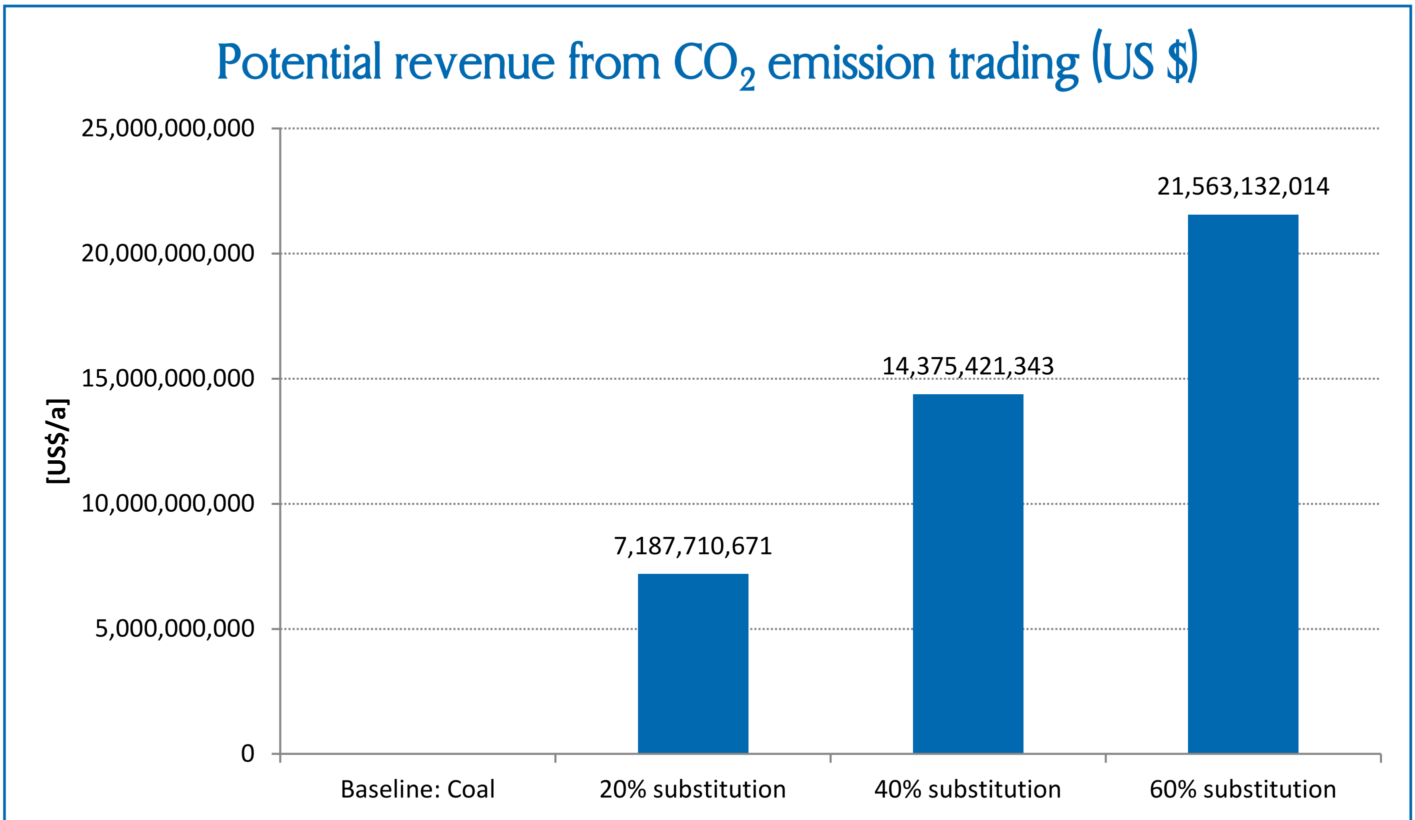

Figure 5: Potential revenue for the cement industry from CO_2 emission trading by substituting coal with RDF

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Circular Economy within the Waste Management - Waste Derived Bags vs Plastic Bags

By Vladimir Dimitrov, MVW Lechtenberg & Partner

I remember the times when there were no single use plastic bags and I was going to the supermarket usually with a multiple use textile bag. Then, at some point everything became single use, from bags for single use to people for single use! Just buy (use) and throw away. As humans I hope we find such behavior deep inside of us, as unnatural.

In this article we compare the production parameters and the related environmental impact of the plastic bag versus a textile bag from waste materials. Or, with other words – a way to substitute products derived from natural resources, such as petrol used for plastic bags, by waste derived materials.

Single use plastic bags

The next figure shows the CO_2 footprint of different types of plastic and paper bags.

Figure 1: Various CO_2 equivalents in kg per bag [1].

Figure 1 shows the CO_2 footprint of the plastic and paper bags varying from 1.58 to 21.51 kg CO_2.

According to Eurostat , the average consumption of lightweight plastic carrier bags with thickness less than 50 microns is 92.7 per inhabitant per year (Table 1 and Figure 2).

TIME	2018	2019
GEO		
European Union - 27 countries (from 2020	94.4	92.7
Belgium	28.2	17.2
Bulgaria	180.6	198.6
Czechia	202.6	247.4
Germany (until 1990 former territory of the FRG	57.2	
Estonia	179.9	152.1
Ireland	53.2	51.5
Greece	111.5	113.3
Spain	186.1	151.8
France	104.2	103.9
Croatia	52.8	94.6
Italy	92.2	111.2
Cyprus	234.3	154.1
Latvia	327.1	284.4
Lithuania	322.5	331.5
Luxembourg	110.6	62.8
Hungary	110.3	86.6
Austria	51.7	37.2
Poland		23.4
Portugal		7.7
Romania	86.1	95.5
Slovenia	79.3	72.8
Slovakia	128.9	104.7
Finnland	156	147.5
Sweden	153.4	149
Norway	146	139

Table 1: Annual consumption per habitant of lightweight plastic carrier bags with thickness less than 50 microns per country according to Eurostat.

Based on that information we can assume that each person in Europe is stimulating the generation of around 146 kg CO_2 per year. With population of 447.7 million people, this makes around 65.5 million tonnes of CO_2 per year.

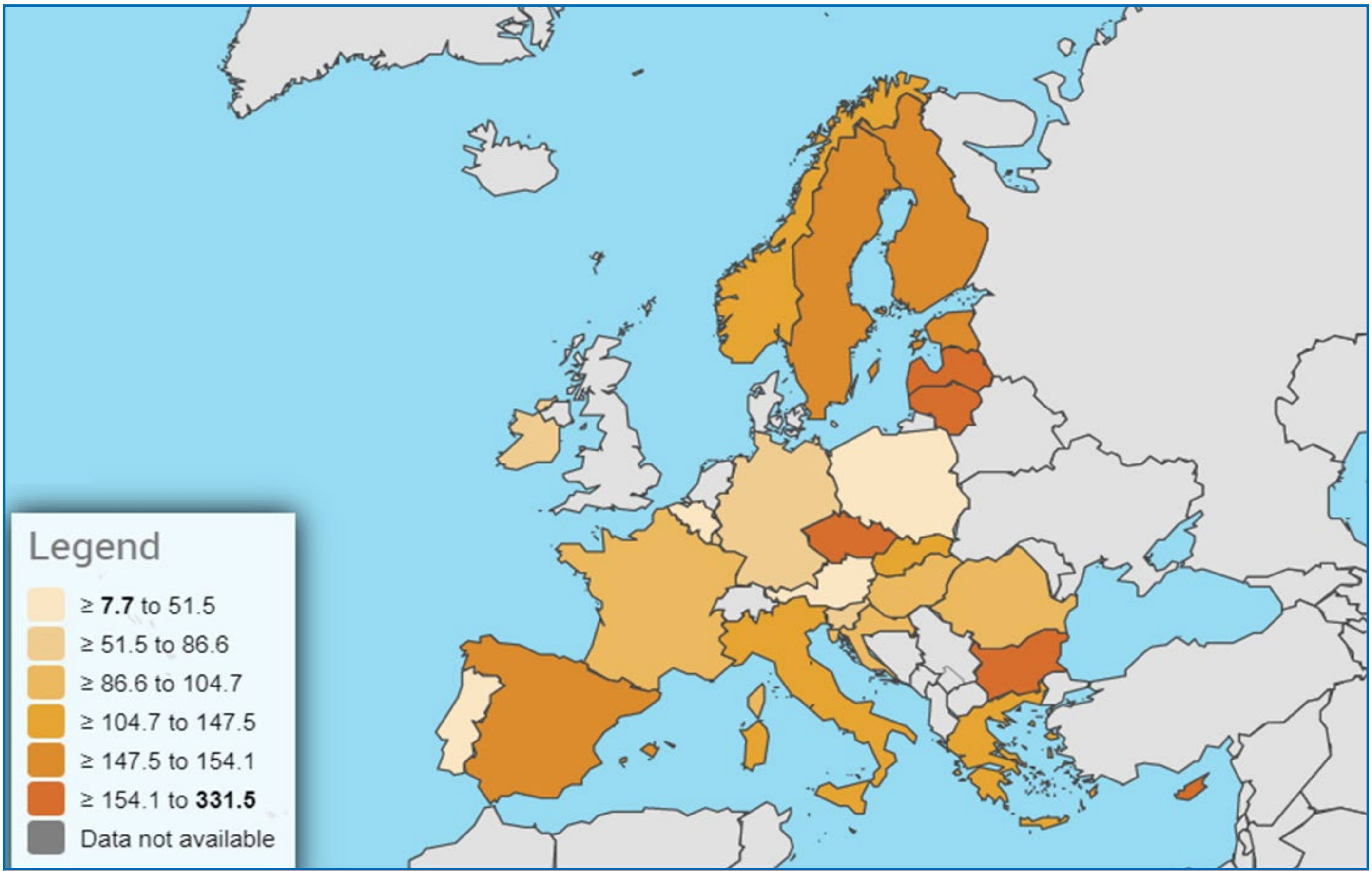

Figure 2: Map showing the annual consumption per habitant of lightweight plastic carrier bags with thickness less than 50 microns per country according to Eurostat [2].

Waste derived bags

Basically, the concept of the waste derived bags is to produce a product for multiple use, from already used widespread recyclable and non-recyclable waste or discarded materials, according to the waste management hierarchy (Figure 3).

The types of materials used for production of the waste bags are second hand or waste materials, which otherwise will be recycled, co-processed or disposed of, which are less desirable practices according to the waste hierarchy. Instead of that, such materials are primarily used for the production of waste bags, which is the more preferred action, namely reuse.

Table 2 shows an example of the composition of a waste derived bag. The origin of each material could be a waste generated by the local industry or collected by the local waste management companies or organizations. The aim is to minimize any negative influence to the environment when compared with the production of conventional products. However, the strategy should always aim at using locally available materials in order to minimize the CO_2 contribution from transport as much as possible.

A lot of clothes could be reused, prior to recycling. Unlike the recycling, reusing does not or require minor energy use. Plenty of materials can be used as bag body – for example clothes (Figure 4), truck covers, etc.

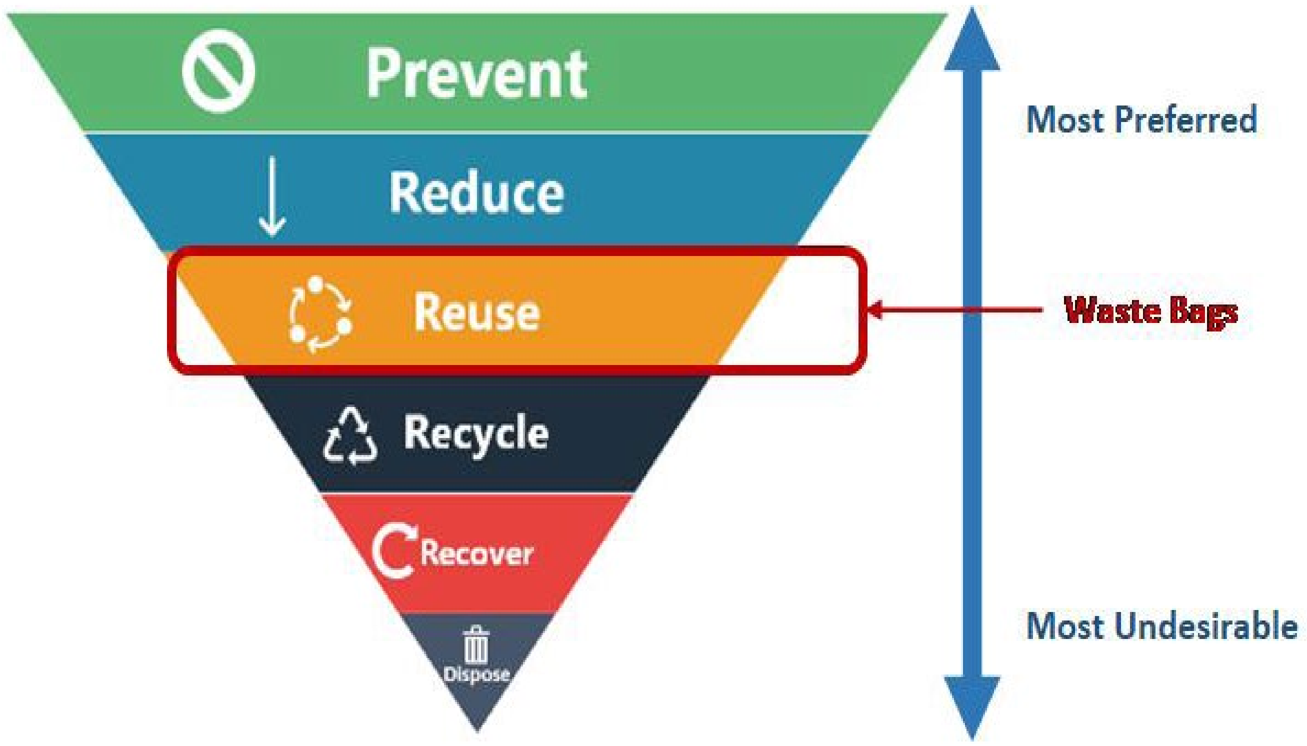

Figure 3: Waste management hierarchy pyramid and the waste bag's location in the hierarchy.

Components	Materials	Type	Origin	Current use	After life
Bag body	Textile	Waste	Clothes	Reuse	Recycling / Energy recovery
Handle	Composite	Waste	Ski	Reuse	Energy recovery
Brand sign	Leather	Waste	Leather cuttings	Reuse	Energy recovery
Thread/Cord	Cotton/ Plastic	New/Waste	Fish nets	Recyclable/ Reuse	Energy recovery
Buttons	Metal	New	Buttons producer	Recyclable	Recycling
Label	Paper	New	Paper recycling	Recycled	Recycling / Energy recovery

Table 2: Example of the composition of a waste derived bag.

Figure 4: Discarded used clothes in Chile. Up to 500.000 tonnes of synthetic fibers from textiles are released into the world's oceans every year [3].

Figure 5: Waste PVC billboard [3]

Figure 6: Truck cover [4]

For example, the handles can be made from composite materials like ski production waste (Figure 7). Usually, such material can't be recycled and will end up in landfills or, will be used in energy recovery as better option. However, before that such material can be reused

Figure 7: Scrapped ski

Figure 8: Mixed ski production waste

Other material which can be used is the leather cuttings (Figure 9), which are usually landfilled or energy recovered. However, in the case of energy recovery, higher quantities have to be taken into account that leather can contain Cr^{+6}, which can be finally found in the cement and causes skin irritation.

Figure 9: Leather cuttings – waste generated from the leather treatment process , [5,6]

Of course, if not each component can be waste derived, recycled, or at least recyclable materials should be used, such as threads, buttons, labels, paper, etc.

Figure 10: Waste derived bag examples [7].

Figure 10 shows an example of a waste-derived bag and a tables with the distribution of the material types by weight and percentage (Table 3) as well the origin of the materials in percentages (Table 4).

The production process of waste derived bags

If we have to analyze the waste-derived bags according the Life Cycle Assessment (LCA). To do this assessment, the current environmental impact have to be assessed and a future targets for improvement will be set, as well as be compared with other similar products. In general, according the LCA, the product lifecycle consists of five phases:

Components	Materials	Type	Weight [grams]	% per type
Bag body	*Textile*	Waste	177	73.9
Handle	*Composite*	Discarded	55	22.7
Brand sign	*Leather*	Waste	2.5	1.1
Thread/cord	*Cotton/plastic*	Recyclable	0.5	0.2
Buttons	*Metal*	Recyclable	4	1.7
Label	*Paper*	Recycled	1	0.4

Table 3: Distribution by weight and percentage of each material type.

Origin of material	Per type
Waste & discarded materials	97.7 %
Recycled materials	0.4 %
New recyclable materials	1.9 %
Total	**100 %**

Table 4: Distribution of the materials origin in percentages.

- Raw Material Extraction
- Manufacturing & Processing
- Transportation
- Usage & Retail
- Waste Disposal

LCA is an internationally standardized method (ISO 14040, ISO 14044) for the evaluation of the environmental burdens and resources consumed along the life cycle of products.

The waste-derived bags concept is referred to as "cradle-to-cradle" (Figure 11) within the circular economy. It is a variation of "cradle-to-grave", exchanging the waste stage with a recycling process that makes it reusable for another product, essentially "closing the loop". This is why it is also referred to as closed-loop recycling.

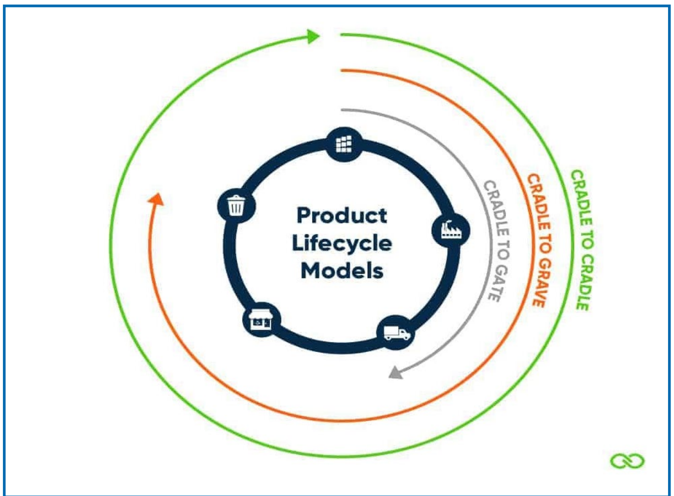

Figure 11: Diagram of different product lifecycle models [8] .

Basically, the production process of waste derived bags includes the following parameters:

Transportation

- Supply of the waste materials, distribution to clients and transport for final utilization.
- The supply of the waste materials, through the client's distribution to the final utilization of the bags is done by vehicles powered by gas or electricity. The output is CO_2 emissions.

The production processes

1. Machine washing of the clothes. The energy input for this process is electricity. The resource used is fresh water. The outputs are wastewater (after washing) and CO_2 emissions, due to the electricity consumed and wastewater treatment.
2. Cutting and shaping of the clothing. It is done manually, so no energy or resources are used.
3. Sewing of the bag is done by sewing machine. The energy input for this process is electricity. The output is CO_2emissions, due to the electricity consumed.
4. The handles are cut and shaped by an electrical band-saw. The energy input for this process is electricity. The output is CO_2 emissions, due to the electricity consumed.
5. The smoothing of the edges and channel formation of the handles are done by electrical emery. The energy input for this process is electricity. The output is CO_2 emissions, due to the electricity consumed.
6. The leather brand sign cutting, shaping, and attachment being done manually by hand tools. No energy or resources are used.
7. Brand engravement is done by an electrical pyrograph. The energy input for this process is electricity. The output is CO_2 emissions, due to the electricity consumed.
8. The attachment of the buttons is done manually by a mechanic tool. No energy or resources are used.
9. The buttons are newly manufactured product. For manufacturing are used metal scrap and energy input depend on the recycling process of the metal and the manufacturing itself.

10. The printing of the label is done by a printing machine. The energy input for this process is electricity. The output is CO_2 emissions, due to the electricity consumed.
11. The attachment of the label is done manually. No energy or resources are used.
12. The paper is a recycled product. For manufacturing, waste paper, water, and energy input are used. The output is CO_2 emissions, due to the electricity consumed and wastewater.

The electricity used for the production is generated by energy mix of non-renewable and renewable sources, and CO_2 emissions will be generated. However, if the electricity is generated only by renewable energy, the CO_2 footprint for the production of the bags will be neutral – zero emissions.

The CO_2 footprint related to transport is a more complicated issue. Even all the logistics to be done by electrical vehicles, the electricity itself should be generated only by renewable energy, which is a huge challenge worldwide. Due to that fact, the strategy should be for all the material supply and distribution to be local in order for logistics to be optimized and CO_2 emissions avoided.

CO_2 footprint & comparison

According to Figure 1 from the start of this article the CO_2 footprint of the plastic and paper bags vary from 1.58 to 21.51 kg, for comparison purpose, in Table 5 the single-use plastic bag is used, which had the lowest CO_2 footprint.

From the other side the waste-derived bag production is shown in 3 scenarios including the logistics contribution as follows:

- Energy mix – using electricity generated by combining fossil and renewable sources for production and transport.
- Neutral production – production of the waste bag using electricity generated only by renewable sources, except the components derived from the market and not the waste management sources (buttons and labels).
- 100% waste – in this case, the energy used for the production is only renewable and all the components of the bag are waste-derived. However, in case 3 only the logistics contributes with CO_2 emissions.

Table 5 shows the production CO_2 footprint of a waste derived bag is significantly lower (from 86% to 96%) even with the logistics CO_2 contribution than the one for a single plastic bag.

Moreover, the life expectancy of a single plastic bag is around 4 days, and the one of a waste-derived textile bag could be much more than 1 year.

Theoretically, by using a waste-derived textile bag instead of single-use plastic one, for a usual application, such as food shopping, daily life belongings like work, sportswear, etc. Only by doing simple shopping, the user could avoid the generation of a significant amount of CO_2. If we imagine that annually half of the time a user takes and uses a waste textile bag, instead of buying each time a single-use plastic bag at the supermarket, this will avoid 73 kg CO_2 and save around 11 € (0,25 €/bag).

At the end of the day, such products (waste-derived bags) are positive for the environment, the process is not considered environmentally significant – no toxic or harmful materials and chemicals are used or generated, but might not have a major influence.

			Energy Mix		Neutral production		100% waste	
Components	Materials	Process	kg CO_2e	%	kg CO_2e	%	kg CO_2e	%
Bag Body	*Textile*	Sewing	0.020(9)	71	0.000	30	0.000	0
		Washing	0.029[11]		0.000		0.000	
Handle	*Composite*	Cutting	0.075[11]		0.000		0.000	
Brand sign	*Leather*	Hand work	0.000		0.000		0.000	
Thread/Cord	*Cotton/ Plastic*	Production	0.000		0.000		0.000	
Buttons	*Metal*	Production	0.023(10)		0.023		0.000	
Labels	*Paper*	Recycling	0.004(11)		0.004		0.000	
Logistic		Transport	0.063[10]	29	0.063	70	0.063	100
Total			**0.214**	**100**	**0.090**	**100**	**0.063**	**100**
Single use plastics bag			**1,58**					

Table 5: CO_2 footprint comparison between single use plastic bag and waste derived bag in 3 scenarios

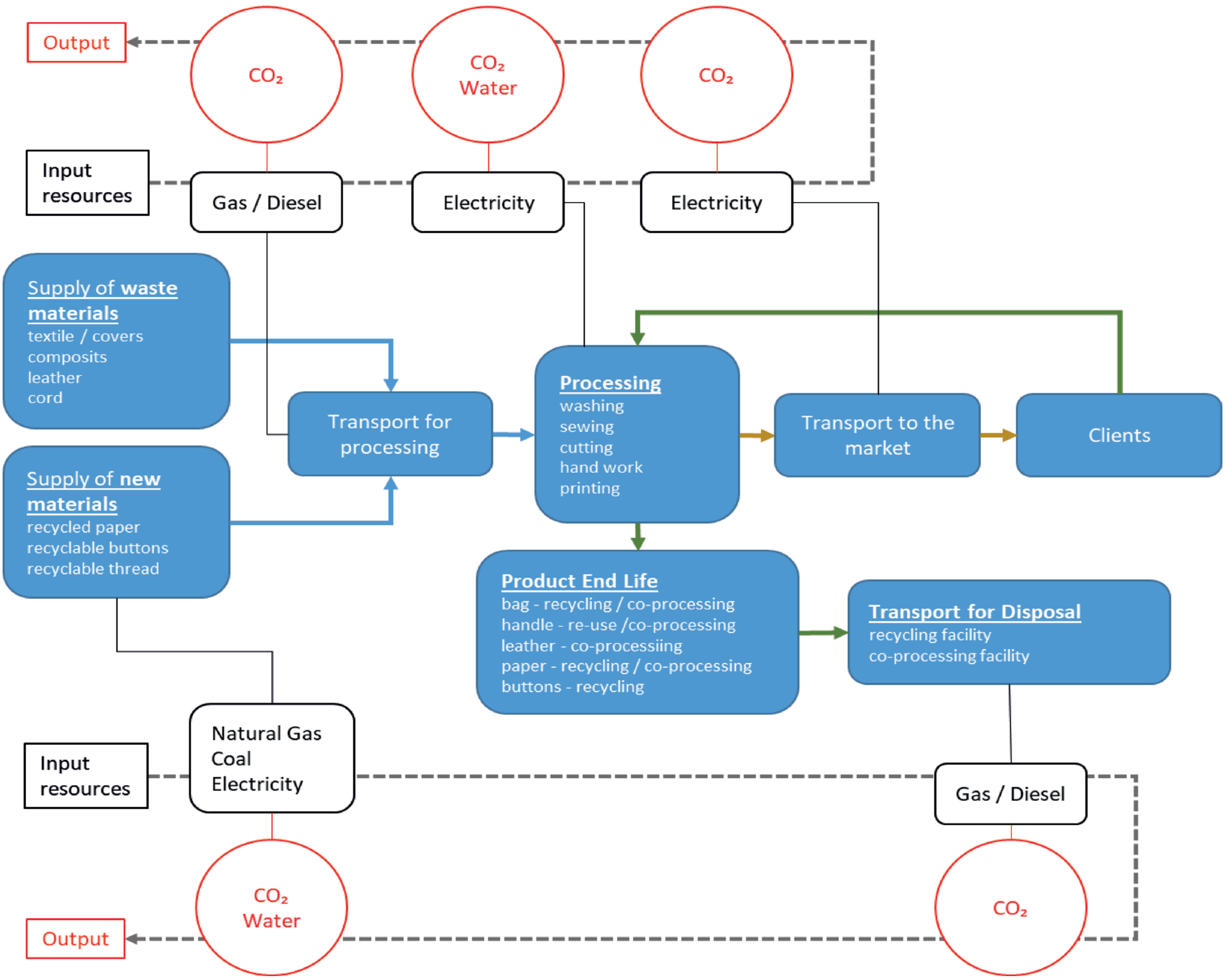

Figure 11: Input and output materials and resources used and generated for waste-derived bags production.

The following are some pros and cons of the waste derived bags:

Advantages:

- Production according to the circular economy rules and the waste management hierarchy.
- Avoid using resources and reduce the environmental negative impact.
- It has a positive social effect and does not stimulate consumer behavior.
- It is made locally with available and local materials, stimulating the local economy and labor.
- High quality of workmanship, uniqueness, and difference of each bag - disposable plastic and paper bags tear more easily from sharp edges and get wet.
- Educational effect – transparent information about good production practices and waste management.
- Saving money in the long term.

Disadvantages:

- Not practical nowadays - the consumer is focused on the products he is going to buy, not how he is going to carry them and what indirect impact the use of disposable bags has, ignoring the problem of overconsumption.
- Larger initial purchase amount.
- Forgetting the bag, due to laziness of the brain, lack of habit, distraction, stress, etc.
- Longer production time.
- Limited market and users.
- Large stocks are not supported.

However, the model and the sustainable way of thinking is more valuable in such products, playing an educational role for the users on the origin of resources and energy used.

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Biomass for Cement Plants: A Case Study from a Cement Plant in Bulgaria

By Vladimir Dimitrov, MVW Lechtenberg & Partner

Introduction

As an example, a Bulgarian cement company, together with the Bulgarian Science Academy, selected and planted experimentally five types of fast-growing species (3 grass species and 3 tree species) "Energy Crops". These energy crops were planted on desolated land located around the plant, owned by the company, with a total area of 200 000 m^2.

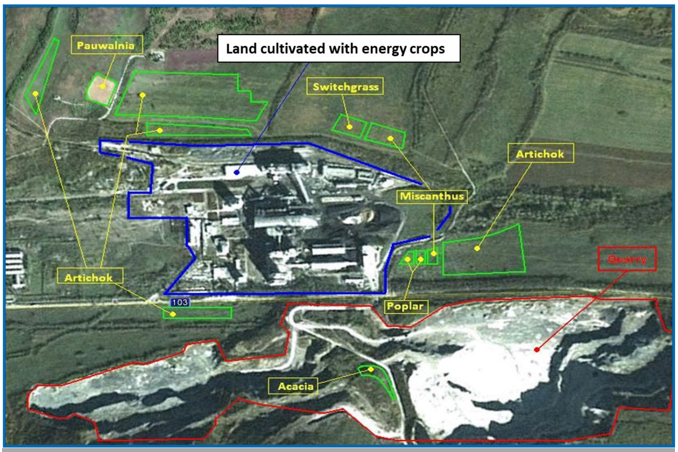

Table 4: Distribution of the materials origin in percentages.

The aim of the experiment was to determine, which of the species are most suitable for growth in the region. The final stage of the experiment would determine which of them are most environmentally, socially and economically suitable to be grown by local farmers and then sold to the cement plant for recovery.

The selected energy crops were chosen on the following criteria:

- The species are perennial, they are planted once and only harvesting and baling is needed for period of 15-20 years.
- The species should grow well on poor lands and require fewer efforts for maintaining through the years in order to minimize expenses.
- The grass dries itself on the field reaching moisture lower than 20-10%, which, of course, depends on the season.
- Because of their perennial type and qualities, the soil is preserved due to fewer pesticides and fertilizers used (only a few times across the upcoming 20 years) and the roots enrich and improve the soil.
- The chosen species must have high annual productivity. Reference data suggested that the yield varies between 0.8 and 2 tonnes (dry matter) per 1 000 m^2, sometimes even 3-4 tonnes, which depends on the climate and the quality of the soil.

The experiment was scheduled to continue for 3 years, due to that the energy crops need 3 years to reach their maximal growth. The final results must be evaluated after completing the second harvest. In the second year the harvest should be 50% of the maximum growth of the grasses. Trees should be harvested in 5 years period.

More specifically, the following parameters had been monitored for all the species:

- Growth per year per 1 000 m^2
- Cost per 1 000 m^2
- Cost per tonne of biomass
- Production rate – tonnes per 1 000 m^2
- Impact on the soil
- Quality parameters – net calorific value and moisture

Miscanthus

Miscanthus is a grass with bamboo-like stems. It is not invasive, but it is very strong. Each year the crop grows new offshoots and becomes more and more wide and tall. The following actions have been done in the first year:

Spring - soil analysis, preparation of the soil, furrows preparation, manual planting of the rhizomes (roots), fertilizer and herbicide application.
Summer – Irrigation when needed.

Picture 1: Land preparation (up), first year miscanthus (down) [1].

The following actions took place in the second year:

- **Spring** - herbicide application
- **Winter** – harvesting

Picture 2: Second year growth pictures in chronological order summer (1) and winter (2). Second year expansion, from 1 root in the first year to several in the second year (3 and 4) [1].

Picture 4: Third year growth in winter

The following actions have been done in the third year:

- **Winter** – harvesting

Picture 3: Third year growth in autumn

After the third-year harvest the total collected quantity was 0.8 tonnes per 1 000 m2. Table 1 shows its quality features.

	November	December	March
Moisture %	42.10	23.55	9.36
NCV kcal/kg			4 173
Volatiles %			75.26
Ash %			7.7
Bulk density kg/m3			117

Table 1: Miscanthus quality in third year [1].

Switchgrass

Switchgrass is planted by seeds. It is not invasive, because it is a hybrid and it is not fruitful. Each year the crop grows new offshoots and become more and more wide and tall. The following actions have been done in the first year:

- **Spring** - soil analysis, preparation of the soil, furrows preparation, seedings, fertilizer and herbicide application.
- **Summer** – Irrigation when needed.

Picture 5: First year switchgrass in summer (left) and winter (right) [1].

The following actions have been accomplished in the second and third years:

- **Spring** - herbicide application
- **Winter** – harvesting

Picture 6: Third year growth of switchgrass [1].

After the third-year harvest, the total collected quantity was 0.5 tonnes per 1 000 m2. Table 2 shows the resulting quality parameters.

	November	December	March
Moisture %	49.21	37.11	4.13
NCV kcal/kg			3 879
Volatiles %			80.55
Ash %			7.22
Bulk density kg/m3			105

Table 2: Switchgrass quality in the third year [1].

Artichoke

The artichoke was planted by a seeding machine. It is not invasive, but it has to be planted each year, which will significantly increase the production cost. The first year saw the following actions:

- **Spring** - soil analysis, preparation of the soil, furrows preparation, seedings, fertilizer and herbicide application
- **Summer** – Irrigation when needed.

Picture 7: First year artichoke [1].

Harvesting and Pre-treatment of Energy Crops

After the crops are grown and dried in the field, the harvesting has been carried out by cutting machines.

The collection has been done on rolls, by paddle application and baled.

	September
Moisture %	
12.3	
NCV kcal/kg	3 656
Volatiles %	74.32
Ash %	9.12
Bulk density kg/m3	124

Table 3: Artichoke average quality [1].

Picture 9: Bailing (up), bales ready for shredding (down)

Picture 8: Harvesting (up), collection (down),

Poplar

Poplar is planted by young 2 years old saplings. The poplar have 5 rotations, which means that can be cut down 5 times during its life and each time new sprout will grow. The trees can be cut down each three, five or more years. The following actions have been executed in the first year:

- **Spring** - soil analysis, preparation of the soil, digging of holes, manual sapling planting, fertilizer and insecticide application.
- **Summer** – Irrigation on a regular basis.

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Picture 10: First year poplar in summer (1 and winter (2) [1].

Picture 11: Second year poplar in summer (up), measurement of the saplings (down) [1].

Acacia

Acacia is planted by 1 year old saplings. The acacia have 5 rotations, which means that can be cut down 5 times during its life and each time new sprout will grow. The trees can be cut down down every third, fifth year or beyond. The acacia was planted in the quarry and was used successfully for recultivation. The following actions have been completed in the first year:

- **Spring** - soil analysis, digging of holes, manual sapling planting, fertilizer application.

Picture 12: First year acacia quarry field (up), second year growth (down) [1].

Paulownia

Paulownia is planted by 1 year old saplings. The Paulownia have 5 rotations, which means that can be cut down 5 times during its life and each time new sprout will grow. The trees can be cut down every third, fifth year or beyond. This tree is pointed to the fastest growing tree on earth. The first year featured the following actions:

- **Spring** - soil analysis, preparation of the soil, digging of holes, manual sapling planting, fertilizer and insecticide application.
- **Summer** – Irrigation on a regular basis.

Picture 13: First year Paulownia [1].

The second and third year saw these measures:

- **Spring** – Hoe the trees
- **Summer** – Irrigation on a regular basis

Picture 14: Third year Paulownia [1].

Own Tree Nursery

In order to secure a continuous tree supply, a tree nursery has been developed in the vicinity of the cement plant.

Picture 15: Young saplings were grown in the nursery [1].

The various types of biomass represent a certain part of the alternative fuels which are co-processed in the cement plant. Motivating the local stakeholders to grow this kind of biomass can be very beneficial for both sides. The cement plant's short-term target was to replace 5% of its fossil fuel with biomass, such as home-grown biomass, wood chips and saw dust and gradually to increase the percentage.

Conclusion

This article highlights some different types of plants that can be grown by the cement plant itself or with the support of local stakeholders. The key issue is to obtain sustainable long-term supply.

References

1. Vladimir Dimitrov. MVW Lechtenberg & Partner

MVW Lechtenberg and Partner Becomes an Associate Corporate Member of WCA

MVW Lechtenberg and Partner is delighted to announce a new memebrship corportaion with The World Cement Association (WCA) as an Associate Corporate Member.

Our commitment towards a corporate culture where global challenges such as demographic or climate changes are managed effectively; not only with focus on the risk, but also on the possibilities and chances resulting in durable and profitable growth both for our customers and our company. We therefore see partnerships as a tool for advancement of the systems and processes at our disposal for sustainability-oriented business activities.

We contribute to a low-carbon economy. With our products and services, we establish a more sensitive handling of resources and a more effective use of available raw materials through co-processing of alternative fuels and raw materials, the combustion of fossil fuels, such as coal, oil and gas can be substituted in the cement, lime and power generation plants. This in turn reduces the CO_2 emissions and therefore represents an environment-friendly opportunity for waste recovery.

With more than 30 years of experience, MVW Lechtenberg & Partners' customers include leading players in the cement, lime, steel industry as well as waste management companies and governments on all continents.

"We are delighted to announce that MVW Lechtenberg & Partners will join our growing membership network. They continue to lead the way in AFR technology and application, enabling firms to significantly reduce CO_2 emissions. MVW brings a clear global perspective to the challenges that cement producers face in increasing AFR usage." said Ian Riley, CEO of the World Cement Association.

We are always curious as our expertise is knowledge based and as such we look forward to more partnerships.

MVW Lechtenberg & Partner Builds the First Refuse-Derived Fuel Production Plant in The Kingdom of Saudi Arabia and Establishes a Subsidiary in Riyadh

MVW Lechtenberg & Partner has been active in Saudi Arabia since 2010 carrying out various consulting projects, including within the framework of the "Mandatory Efficiency Programme" of the Ministry of Environment, which assists the local cement industry with energy-efficient cement production.

MVW Lechtenberg also carried out an extensive "Fuel Switch" study for the government, to calculate the potential for renewable energies and the resulting savings potential of fuel for all energy-intensive industries (the petrochemical industry, steel, aluminum industry, the cement industry, etc.). As part of the study, MVW Lechtenberg & Partner calculated a possible savings potential of around 38.6 million barrels of fuel among other things through the use of up to about 4.7 million tonnes of alternative, waste-based fuels.

The cement industry in Saudi Arabia has a current production capacity of around 85 million tonnes of clinker, with actual production last year (2021) being 54 million tonnes. In late 2020, MVW Lechtenberg started working on a project with the City Cements Company in Marat (about 130km from Riyadh) to establish a pilot plant for the production and use of alternative fuels which is still ongoing and being supervised and constructed.

In March 2022, another plant was planned and put into operation in Riyadh by MVW Lechtenberg & Partner.

Inauguration of the material recycling and RDF production facility by SIRC in the presence of the President of the National Waste Management Center HE Dr. AbdullahAI Sibai, the CEO of SIRC and a member of the Managing Board of Green Environmental Solutions Company (GES-Co), Majed Al Osailan

This time as a joint venture between the companies; "Green Environmental Solutions" a subsidiary of the City Cement Company, "Saudi Investment Recycling" also known as SIRC, a company of the Saudi Public Investment Fund (PIF) and the subsidiary of MVW Lechtenberg & Partner in Saudi Arabia, "MVW Lechtenberg Middle East" in Riyadh.

Workers sorting recyclable materials at RDF facility in Riyadh

Municipal waste serving as raw material in the RDF facility.

Around 600 tonnes of household waste are processed in the plant every day. The recyclable materials (cardboard, paper, glass, metals, plastics, etc.) are sorted out and the organic fraction is pre-treated for compost production, while the non-recyclable materials are processed into specified alternative fuels for the local cement industry.

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Global News

Waste-to-hydrogen to play 'major role' in circular economy of the future

Global industry is entering a phase of energy transition as a result of the adoption of decarbonization, decentralization, and digitization, also referred to as the "three D's." During this time, conventional fossil-fuel based sources are gradually being replaced by sustainable, renewable alternatives, advancing and reshaping the way that global energy systems function.

Decarbonization is one of the primary forces behind the so-called Fourth Industrial Revolution, driven by advancements in lower-carbon energy sources including liquefied natural gas (LNG), hydrogen, and biomethane.

Reducing emissions in industries that are notoriously difficult to regulate, such waste management, the fourth-largest source of emissions, the steel industry, and cement manufacturing, is a critical component of decarbonization.

A significant amount of the hydrogen produced from municipal solid waste (MSW), which comprises around 50% biomass, may be viewed as renewable.

Source. Gasworld.com

Zero Waste Europe states that each tonne of MSW burned generally emits between 0.7 and 1.7 tonnes of CO_2, which includes emissions of both fossil CO_2 from burning biomass and items like burning plastics.

Following the removal of recyclable materials, the waste is shred and dried, a process that may be made more energy-efficient by using waste heat from the procedures that come after.

Around 950^0 C is the temperature at which reforming occurs, which produces hydrogen and converts heavy tars into short-chain hydrocarbons.

The development might supply enough garbage to feed a waste-to-hydrogen plant for more than ten years, he said, adding that other waste-to-hydrogen projects have already been built to utilise older landfill sites as energy resources.

"Waste-to-hydrogen can assist prevent extra methane emissions that may be caused by these dump sites in this way."

Source: https://www.gasworld.com/waste-to-hydrogen-to-play-major-role-in-circular-economy-of-the-future/2023888.article

Africa

Nigeria - Anambra State set to establish a sewage treatment plant

The Anambra State Government announced intentions to build a sewage treatment facility to provide the state's wastewater with a much cleaner and more environmentally friendly solution.

Source. xtra.net

The statement was made by Mr. Felix Odimegwu, the state commissioner for the environment. According to Mr. Odimegwu, the program is a part of the governor's led administration policy to make the state cleaner, greener, liveable, and prosperous for its citizens. He claims that the objective is to deliver significantly cleaner and more environmentally friendly wastewater.

The sewage treatment plant in Anambra will be located in the Oyi Local Government Area near Nkwelle. The Refuse Derived Fuel (RDF) generated will be used to create energy.

The Commissioner announced that the state would soon start systematically picking up waste from house to house in order to gradually phase out the dumping of trash on the street or highways and that the sewage treatment plant will be located in the Oyi Local Government Area near Nkwelle. Additionally, the plant is projected to be used for the processing of the waste into Refuse Derived Fuel (RDF), which can be used to create energy.

Source: https://www.xtra.net/news/metro/official-anambra-set-establish-sewage-treatment-plant

Senegal - SENELEC is launching a waste-to-energy project in Kaolack

The National Integrated Waste Management Company (SONAGED) and the Senegalese National Electricity Company (SENELEC) are collaborating to turn waste into energy in the western city of Kaolack, despite the fact that Senegal produces 200,000 tonnes of plastic waste annually, of which only 9,000 tonnes are recycled.

Source. afrik21

In Kaolack, a city 223 kilometres from Dakar, the Senegalese National Electricity Company (SENELEC) will turn waste into electricity.

According to Papa Demba Biteye, Director General of SENELEC, "We will take all necessary measures for the start-up of this first power plant to create energy from waste, so that what has been our weakness up to this point may be our treasure, namely garbage. If completed, this project will help Senegal reduce its pollution levels".

According to the government, just 9,000 tonnes of the 200,000 tonnes of garbage produced annually in this West African nation are recycled.

Source: https://www.afrik21.africa/en/senegal-in-kaolack-senelec-is-launching-a-waste-to-energy-project/

Americas

Brazil - Renova and UNTHA collaboration produces RDF in single step

In a cutting-edge partnership with the producer of industrial shredders UNTHA Iberica, the Brazilian company Renova Group, a specialist in industrial waste, has improved its alternative fuel capabilities. The family-run company has installed a single-step RDF (refuse-derived fuel) manufacturing system that enables them to convert waste into a sustainable energy source while utilizing just one shredding machine. The plant's core currently houses a UNTHA XR30000C waste shredder, which generates uniform 50mm fuel for the cement industry.

Source. hub-4

The reuse, recycling, and recovery of commercial and industrial "waste" is nothing new to Renova Group. The company has five industrial locations around the nation and has been gathering and processing various commodities for 36 years, including metals, textiles, plastics, rubber, and wood.

Source: https://hub-4.com/news/renova-and-untha-collaboration-produces-rdf-in-single-step

Columbia - New plant converts waste into RDF for Columbia's cement industry

To further its Energy-from-Waste (EfW) activities in Colombia and produce Refuse Derived Fuel (RDF) for the cement sector, Geofuturo has purchased a UNTHA CR2000 shredder. The machinery will handle about 2200 tonnes of materials per month at the company's new EfW plant, Geoparque, in Cartagena.

On Tuesday, August 23, the facility was officially opened in front of over 100 industry professionals and representatives, including representatives from the Colombian environmental agencies, the Austrian Chamber of Commerce, cement manufacturers, and waste management businesses.

Waste wood, textiles, plastics, and even leather that would have otherwise been disposed of will now be processed by the shredder. Olga Lucia Gaviria, manager and creator of Geofuturo, commented on the justification for the investment and stated: "Our objective is to support the circular economy by offering sustainable choices for waste management".

Source. World cement

In addition to supporting our operations, the shredder will assist our nation meet its environmental goals. The Carbon Neutral Colombia policy was introduced in 2021 by Colombia's Ministry of Environment and

Sustainable Development with the goal of becoming carbon neutral by 2050. “This initiative will assist us to harness the resource potential of garbage that is presently being dumped in our country, providing a valuable and alternative energy source that helps to minimize our country’s use of ever-dwindling fossil fuels,” added Olga. By the third year of the plant’s operation, the company anticipates a nearly 6% reduction in the quantity of waste transferred to the nearby landfill in Cartagena.

Source: https://www.worldcement.com/the-americas/19082022/new-plant-converts-waste-into-rdf-for-columbias-cement-industry/

United States - National Cement Company of Alabama’s Ragland Cement Plant to Upgrade to reduce CO_2 emissions by 40%

The new kiln line at the Ragland cement factory, according to National Cement Company of Alabama, would cut the plant’s CO_2 emissions by 40%. The improvement will also result in a 30% reduction in energy usage. The new line has a vertical crusher, a five-stage preheater, a 78 m high homogenization silo, and an automated clay storage system. Waste tires, wood chips, and sawdust will all be utilized as AF in the kiln. By 2023, the Ragland Cement Plant will be producing 100% Portland Limestone Cement (PLC), reducing its carbon impact even more.

Guy Sidos, CEO of Vicat, remarked “In all of our cement facilities across the world, we hope to employ AF. Our initiatives actively support local development in addition to substituting fossil fuel energy with recycled regional waste. We take great pride in the modernization and redevelopment of our Ragland location, which we acquired in 1974 as our very first property outside of France”.

Source: https://www.globalcement.com/news/item/14420-national-cement-company-of-alabama-s-ragland-cement-plant-upgrade-to-reduce-co2-emissions-by-40

Asia

Indonesia - Jakarta to conduct a green fuel RDF production trial from October – December 2022 with full operation expected to start in January 2023

From October through December 2022, the Jakarta Environmental Office will test the generation of Refuse Derived Fuel (RDF) from waste that has been processed at the Bantargebang Integrated Waste Management Site (TPST).

The RDF processing facility at TPST Bantargebang has a daily capacity of processing 2,000 tons of waste to create 750 tons of RDF in the form of environmentally friendly coal. One thousand tons of new waste plus one thousand tons of leftover waste made up the two thousand tons of waste. RDF, meantime, may be used as a substitute fuel in cement plants to lessen air pollution.

An agreement on the use of RDF products with two cement firms will be signed after the construction of the RDF facility, which is over 70% complete, is scheduled to be finished in October 2022. The two cement factories would utilize the RDF for 10 to 15 years as per the partnership plan.

The Bantargebang landfill, which had a height of up to 50 meters and a volume of around 50 million cubic meters of waste will be reduced by the RDF

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processing facility. The reduction of waste at TPST Bantargebang allows for the reuse of fresh land in addition to generating green fuel for energy from RDF and compost.

Source: https://en.antaranews.com/news/251129/jakarta-to-conduct-green-fuel-rdf-production-trial-in-october

India - Cement firm (JK cement) to help Municipal Corporation Delhi (MCD) get rid of RDF at landfills

In order to elevate the refuse-derived fuel (RDF) stored at the city's three landfills, the Municipal Corporation of Delhi and JK Cement have signed a memorandum of understanding (MoU). The scheme would enable MCD to yearly save Rs 6.73 crore.

Source. LinkedIn - Singhania Madhav

After the arrangement was signed deputy governor VK Saxena flagged off five trucks leaving the Okhla dump site with almost 100 MT of RDF.

According to an MCD official, JK Cements would be lifting 50,000 metric tonnes of RDF yearly, saving MCD Rs 6.73 crore in the process. On the LG's recommendation, samples of RDF were collected from dumps to determine their value to industries.

Source. LinkedIn - Singhania Madhav

The official stated, "The samples were judged to be appropriate and MCD was told to contact cement businesses for delivering RDF on a payment basis." Future empanelment may include more cement companies.

Source. LinkedIn - Singhania Madhav

Source: https://timesofindia.indiatimes.com/city/delhi/delhi-cement-firm-to-help-mcd-get-rid-of-rdf-at-landfill/articleshow/93863821.cms

Kuwait to build refuse-derived fuel plant

Kuwait is preparing to construct its first facility to create dry fuel from solid waste called refuse-derived fuel, or RDF, to supply its primary cement producing firm.

Kuwait Municipality has authorized the project to turn waste into dry fuel to fire kilns at the Kuwait Cement Company (KCC). The Municipality will

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soon sign a deal with KCC for investment in the project to provide fuel to the company and other local enterprises, according to "informed sources" cited in the article.

The factory, which has a floor space of around 250,000 square meters, will mostly treat "non-biodegradable trash" like plastics and will be built within 18 months of the contract's signature.

KCC would "invest and manage" the project for at least 20 years while also generating biogas, biofuel, fertilizers, and other related goods. "The Municipality has already recruited a consultant for the waste derived fuel project, which might be developed next to the waste dump at Mina Abdullah".

Source: https://www.zawya.com/en/projects/industry/kuwait-to-build-refuse-derived-fuel-plant-ivjp-gdzc

Philippines - Cemex Philippines showcases co-processing technology at DENR solid waste management summit

The Department of Environment and Natural Resources' (DENR-NCR) Solid Waste Management Summit recently held at the Manila Hotel featured a presentation from CEMEX Philippines on its co-processing technology.

The summit's theme was "Strengthening Waste Management for a Healthier Environment," and Atty. Christer Gaudiano, Director of ERM, Corporate Communications, and Public Affairs at CEMEX Philippines, emphasized how the company has been managing solid waste successfully and working with local government units (LGUs) and the private sector to promote sustainable waste management.

Source. CEMEX

The DENR has acknowledged CEMEX's co-processing technology as a sustainable waste disposal method that has been successfully tested. It makes use of a cement kiln, a furnace that runs at extremely high temperatures of around 1,500 degrees Celsius and ensures that waste and toxic compounds completely decompose. The system gets rid of leftover waste, which eventually frees up landfill space.

As part of the company's "Future in Action" global campaign to combat climate change, solid waste management is a key component. With this plan, the goal is to cut carbon dioxide emissions by 35% by 2025 and by 40% by 2030. The long-term objective of CEMEX is to achieve net-zero CO_2 emissions by 2050.

Source: https://manilastandard.net/spotlight/314248315/cemex-showcases-co-processing-technology-at-denr-solid-waste-management-summit.html

Philippines - Holcim Philippines to co-process Panacas's plastic waste at Davao cement plant

Holcim Philippines has signed an agreement In order to receive and co-process 6.5 t/yr of shredded waste from the Panacan barangay of Bunawan municipality as an alternative fuel (AF) in its cement manufacturing. The AF will be processed by Holcim's waste management affiliate GeoCycle.

"We are grateful for their trust and happy to provide our host barrio Panacan a sustainable waste management solution," said Sam Manlosa, manager of the Davao cement factory. We are hoping that this cooperation will grow to include other local governments and the entire city of Davao so that we may contribute more effectively to its long-term development".

Panacan is the 28th community in the Philippines to collaborate with Holcim Philippines for waste management, making it the company's 18th new partner in 2022. The business obtained supplies of trash gathered in the Rizal provincial municipalities of Binangonan, Cainta, and Taytay for co-processing at its Bulacan cement factory in August 2022.

Source: https://www.globalcement.com/news/item/14626-holcim-philippines-to-co-process-panacan-s-plastic-waste-at-davao-cement-plant

Europe

Europe - Energy crisis threatens European plastics reclaimers

The European energy crisis has increased power costs to the point where they now account for 70% of operational costs for plastics recyclers. Without assistance, these businesses risk having to shut down.

On September 22, Plastics Recyclers Europe (PRE) issued a warning that the continent's plastic recycling industry's costs are rising drastically due to high energy prices, which are being exacerbated by the economic sanctions imposed in reaction to Russia's invasion of Ukraine

Source. MVelishchuk/Shutterstock

According to PRE, after labor and maintenance, energy costs are often among the top three biggest operating expenses for facilities, accounting for 15% to 20% of operational expenses. But according to PRE, which got that figure from a survey of its member firms, energy expenditures are now accounting for 70% of operational costs due to soaring natural gas and power prices.

Italian facilities for recovering plastics are already shutting or scaling up their activities. According to Ton Emans, president of PRE, "Stopping the recycling efforts will have an immediate, detrimental impact on the management of plastic trash in Europe." Plastic recycling must be viewed as a crucial industry area to be targeted by Member States' attempts to defend against the effects of rising power costs "if we want to promote a circular economy in Europe."

Source: https://resource-recycling.com/plastics/2022/09/28/energy-crisis-threatens-european-plastics-reclaimers/

Bulgaria - Bulgaria cement plant gets EU to grant for innovative carbon capture, storage project

Devnya Cement received EUR 190 million from the EU Innovation Fund to work on the first full-chain carbon capture and storage project in the Balkans. According to the European Commission, Bulgaria and the bordering areas of Romania and Greece will soon form a CCUS cluster.

The Bulgarian affiliate of HeidelbergCement was chosen by the European Commission as one of the recipients of funding from the Innovation Fund during its third call. The country's north-eastern Devnya Cement facility plans to capture carbon dioxide produced by its operations and pump it to the depleted Galata offshore gas reserve under the Black Sea for long-term storage.

Source. HeidelbergCement

The ANRAV project was awarded a grant for EUR 190 million. Private finance will be used to make up the remaining portion of the investment. The company's cutting-edge clinker and cement facility in the city of Devnya is where the carbon capture system will be constructed and installed.

In contrast to over EUR 1 billion last November, the European Commission authorized EUR 1.8 billion in total this round. The 17 chosen projects span countries including Bulgaria, Finland, France, Germany, Iceland, the Netherlands, Norway, Poland, and Sweden and deal with energy-intensive sectors like cement, chemicals, hydrogen, and fuel refineries. The Innovation Fund also provided funding for three other CCS initiatives for the cement sector in Germany, Poland, and France.

Source: https://balkangreenenergynews.com/bulgarian-cement-plant-gets-eu-grant-for-innovative-carbon-capture-storage-project/

Norway - Norway's EA approves full scale CCUS plant at Brevik

The Norcem plan to construct a full-scale CO_2 capture (CC) facility at the company's Brevik factory has been given the green light by the Miljdirektoratet environmental regulator in Norway. Based on an application and consultation procedure, the environment agency modified Norcem Brevik's Porsgrunn municipality pollution permit.

According to Ellen Hambro, director of the organization, the new permit permits the Heidelberg Materials-owned firm to cut its CO_2 emissions by 400,000t, or almost 50%. Additionally, the control of CO_2 is anticipated to result in fewer emissions of dust, fluoride, and ammonia as well as a reduction of up to

80% in the emissions of chlorine and sulphur dioxide. Additionally, it is anticipated that the mercury and dioxin concentrations in the outflow to the sea will be lower, such that they won't have a discernible impact on the Eidanger fjord.

The Brevik CCUS plant will be the first significant CC facility in Norway and the first full-scale CC facility in a cement factory in the whole world. It belongs to the Langskip initiative for CCUS from Norwegian businesses.

Source:https://www.cemnet.com/News/story/173544/norway-s-ea-approves-full-scale-ccus-plant-at-brevik.html?source=864a0f3bf67135139cf-4d7220a9d7714

Middle East

UAE - BEEAH starts operations at its RDF plant in Sharjah

BEEAH Recycling Company, a subsidiary of the Sharjah-based BEEAH Group, has begun operations at its Solid Recovered Fuel (SRF) plant, which is a part of the BEEAH Waste Management Complex in Al Saja'a, Sharjah. The facility will turn commercial waste into high-quality Refuse-Derived Fuel (RDF), which can be used as an alternative to coal in a cement factory kiln.

The SRF facility's approach to waste processing is unique to the area. It generates a high-value, low-moisture, low-chlorine alternative green fuel that is more environmentally friendly and emits fewer greenhouse gases than coal, which is normally used to make cement. Currently, the SRF facility is capable of producing 250 tonnes of alternative green fuel each day, or 85,000 tonnes annually.

Source. Zawya

A deal has been made for Sharjah Cement to obtain 73,000 tonnes of alternative green fuel annually from the SRF plant, which is near BEEAH Recycling's Waste Management Complex. CEO of Sharjah Cement Pravinchandra Batavia stated, "We are thrilled to join into this cooperation with BEEAH Recycling. We will be able to successfully achieve production targets, get closer to our sustainability goals, promote a circular economy, and help reduce emissions by employing this high-efficiency green coal substitute".

Source: https://www.zawya.com/en/business/energy/uae-beeah-group-opens-new-recycling-facility-to-produce-alternative-green-fuel-from-waste-pkyw9uy

UAE - ADNOC Refining to complete the first phase of the waste heat recovery project

At the General Utilities Plant in Ruwais, Abu Dhabi, ADNOC Refining, a joint venture between the Abu Dhabi National Oil Company (ADNOC), Eni, and OMV, plans to finish the first stage of its Waste Heat Recovery project. The Waste Heat Recovery project would reuse waste heat generated by the plant to create up to 230 MW of power each day.

According to the UAE's Net Zero by 2050 Strategic

Initiative, ADNOC produces some of the least carbon-intensive petroleum in the world and is further aiming to cut its greenhouse gas (GHG) emissions intensity by 25% by 2030.

The Waste Heat Recovery project, which builds on the company's history of responsible environmental management, is one of many strategic projects to decarbonize ADNOC's activities, according to the statement.

The Waste Heat Recovery project, which cost $600 million (AED 2.2 billion), began in 2018 and would reuse waste heat from the plant to create up to 230 extra megawatts (MW) of energy daily, enough to power hundreds of thousands of households. Additionally, it will daily create 62,400 m^3 of distilled water for the plant. The upgrade, according to the statement, would boost the plant's thermal efficiency and electricity generation by almost 30% without adding any new carbon dioxide emissions.

Source: https://www.wasterecyclingmea.com/news/waste-to-energy/adnoc-refining-to-complete-first-phase-of-waste-heat-recovery-project

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MVW Lechtenberg
Projektentwicklungs– und
Beteiligungsgesellschaft mbH

Managing Director:
Dirk Lechtenberg
Dammstr. 11a,
47119 Duisburg Ruhrort

VISDP: Dirk Lechtenberg
Editorial Director:
Dirk Lechtenberg

Tel. +49 (0) 203-34 65 16-0
Fax. +49 (0) 203-34 65 16-50
e-mail: sales@lechtenberg-partner.de

www.lechtenberg-partner.de