Funded by
the European Union

Implemented by
Stantec consortium

BRIEF MISSION REPORT

5 - 10 March 2023

Mission to Belgium

April 2023

Benchmarking and Knowledge Exchange Visit to Belgium

Prepared for:

European Union Delegation to Ethiopia

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Contract Number:

FED/2019/412-677

Contents

1. Executive Summary

The exchange visit was carried out as a Learning and Networking Tool to evaluate and discuss sustainable developments and achievements in utilising AF/RDF waste as fuel in order to enhance the development of alternative fuel including Refused Derived Fuel (RDF) and scale up the Prosopis Juliflora (prosopis) alternative biomass Fuel production to replace fossil fuel (coal) in the Ethiopian cement industries under the Climate Change programme promoted by the European Union Delegation to Ethiopia. Prosopis has invade about 2 million hectares in the Afar and the Somali regions of Ethiopia. The caloric values of Prosopis range from 4200 to 4900 Kcal/Kg hence being an important source of biomass energy for coal replacement currently used by the cement factories. To materialize the fuel switching project, the government has already deployed a biomass harvesting and processing system in collaboration with the national cement.

In addition, a feasibility study to analyze the potential Refused Derived Fuel (RDF) production at Koshe Dump site has been conducted. The study is conducted as part of the ongoing support to the Industrial fuel switching assistant within the framework of the current EU's climate change budget support. The Technical Assistant (TA) project has made collaboration with Panda Manufacturing PLC and the Addis Ababa Solod Waste Management Agency (AASWMA), the initiator and the owner of the work for the implementation of the study. The laboratory analysis results (conducted in Germany by MVW Lechtenberg & Partner) show a net calorific value (NCV) of 19,247 KJ/kg (including recyclables) and 22,837 KJ/kg (excluding recyclables). This can be considered a good result compared with a general requirement in RDF production which is >14,700 KJ/kg. Only by considering dumped waste at koshe Reppi land fill site which is about 638t/d and excluding recyclables, it estimated that a production of 27, 000t/y of RDF is possible.

Moreover, the mission will help to benchmark for comparing and evaluating the existing technology of the cement companies with Ethiopian cement industries. It is expected that the best experience will be shared from the visited world class cement production industries.

Herewith, enrolled below observations and recommendations with indicative pictures from site followed by recommendations.

2. Introduction and Context

The Ethiopian 10-Year Development Plan portrayed that the share manufacturing sector will reach as high as 17.2% of GDP by 2030. This in turn increases emissions from the sector in the coming years. Hence, different interventions have been proposed to reduce emissions from the sector in the coming years. The Updated Nationally Determined Contribution (UNDC) portrayed that the planned intervention will reduce emissions levels to 22.6 Mt CO2 eq in 2030 in the conditional pathway. This equals to a relative reduction of emissions 13.4 % (-3.5 Mt CO2 eq) compared to BAU emissions. The cement sub-sector is identified as the major process related emission in the manufacturing sector. In the cement sub-sector, fossil fuel substitution with alternative fuels (such RDF) is identified as one of the greenhouse gas abatement strategies for the cement sub-sector.

Cement manufacture is a highly energy-intensive process, and the total energy consumption of the global cement industry is estimated at 2% of global primary energy use. The cement production process attributes to the emission of CO2 through the decarbonisation of limestone and from the combustion of fossil fuels, which cover about 5% of anthropogenic global CO2 emissions. In the cement industry the expenditure of energy estimated 20-40% of operational costs from the total, which exhibited the energy costs, are a significant part of the total production costs. In general, the energy efficiency of cement making has a direct impact on overall energy consumption, CO2 emissions, and energy costs, making it the primary strategy to reduce the environmental impact of the globally second-largest industrial emission source.

As part of the ongoing support to the Government of Ethiopia's climate change initiatives, the European Union has allocated a fund in the form of budget support in support of key sectors of climate change action that are forestay, industry (focusing on cement industry), the national Measuring-Reporting-Verification system, and sectoral Public Management. This support will take the form of a Sectoral Reform Performance Contract supported by Complementary technical assistance running for three years, 2020-2022. One of the main beneficiaries of the budget support and the main responsible body for the achievement of the targets sets under the budget support for the cement sub-sector is the Ministry of Industry. Accordingly, the target expected to be achieved from the cement sub-sector is a reduction of the national average GHG emission in tone of CO2e in Ethiopia's cement manufacturing from 0.667 tCO2e per tone of cement to 0.628 tCO2e. The activities shall be implemented with close cooperation with Ethiopian Cement Producers Association (ECPA) on Ethiopian cement factories.

The Ministry of Industry and Ethiopian Petroleum and Energy Authority are implementing various initiatives in the industrial sector in the areas of energy efficiency, energy management system implementation, energy audit in industries, and fuel switching in cement industries (biomass and Refused-Derived Fuel-DF). In addition, the Addis Ababa cleansing agency (former solid waste management agency) and private stakeholders are planning to implement an RDF production facility in Addis Ababa solid waste dumping site ''Koshe''. All these projects contribute significantly to reducing CO2 emissions from the industrial sector.

In order to acquire expertise and knowledge in energy management and the use of alternative fuels in the manufacturing sector, a knowledge exchange and experience sharing mission to Belgium was carried out. The businesses and facilities which have been visited

have a history of producing high-quality Refused Derived Fuel (RDF), carrying out regular energy audits, implementing energy management systems, and working on projects to reduce emissions, such as carbon capture, transportation, and storage. Five people made up the delegation, including His Excellency Ato Tarekegn Bulbulta, State Minister for the Ministry of Industry.

3. Objective of the visit

The General Objective of the benchmarking visit was to enhance Ethiopian potential stakeholder knowledge and understanding of Alternative Fuel/AF potential including RDF and its positive contribution in waste management, fossil fuel substitution, environmental and climate change efforts.

Therefore, the goal of undertaking the trip was to exchange knowledge, ideas, experiences and lessons about new technologies and best practices of leader facilities worldwide on this field, with a clear focus on learning from the various processes in making such market more functional and incorporating the best practices to well incorporate and use AF/RDF waste as fuel in Ethiopia and able to maintain acceptable standards.

The Benchmarking and knowledge exchange program sought to realize the under-mentioned specific objectives:

- Visit AF production facilities and AF applications in industries like cement.
- Discuss on the above, including their contribution to fossil fuel substitution and environmental protection.
- Familiarize the project team with each other for knowledge sharing and peer project implementation spirit.
- Learn from pilot project implementation experiences and enhance the capacities of the team’s action learning through exposure to success stories on the ground and knowledge sharing.
- Discuss future development and improve cooperation in AF development.

4. Organization and Program

4.1 Organization of the mission

The mission was organized in collaboration between Stantec and PECO Energy Company based in Tunis. In fact, all arrangements relating to international return flights and accommodation were exclusively arranged by Stantec through the climate change sector reform performance project to Ethiopia funded by the European Union (EU). In this context, PECO Energy has provided two specialized facilitators with strong facilitation skills and an understanding of both visitors and hosts facilities in order to provide assistance in visiting facilities and prepare the visit, identifying topics and locations of common interest to help visitors concentrating on the substance on their concerns.

4.2 Participants / Composition of the Delegation

The state minister for the ministry of industry, the project manager for the climate change sector reform project, and the director of energy efficiency and conservation from the Ethiopian Petroleum and Energy Authority made up the Ethiopian delegation. Five people in

total have taken part in the mission. The table below displays the specifics. The delegation was composed of the following members:

No.	Names	Organizations	Positions
1	Samuel Halala	Ministry of Industry	Project Manager, EU Climate Change Sector Reform
2	Tarekegn Bulbulta	Ministry of Industry	State Minster
3	Takele Desisa	Addis Cleansing Agency (former solid waste management agency)	Director, Research and Project Implementations Directorate
4	Zewge Worku	Ethiopian Petroleum and Energy Authority	Director, Energy Efficiency and Conservations
5	Addisu Amare	EU Technical Assistance	Energy and Environment Expert, EU Climate Change Sector Reform programme

4.3 Schedule and itinerary of the onsite visit

Having the objectives, the visit was designed to help The CCSRPC Project supports the Ethiopian Ministry of Industry in implementing industry-related mitigation interventions in energy efficiency, energy audit and fuel switching in the cement sub-sector.

The visits lasted for four days (March 06-09, 2023) and emphasized peer learning and sharing know-how with European facilities through the following agenda:

Day 1: 6 March 2023	
09:30 -12:00	Antoing Cement plant visit
12:15 – 13:45	Lunch break
14:30 – 16:30	Alterline Presentation in the hotel or office in Brussels: Sustainable Landscape Restoration: The ILE DOTUN Project
Day 2: 7 March 2023	
09:30 -12:00	Lixhe Cement plant visit
12:15 – 13:45	Lunch Break
14:30 – 16:30	Recyfuel Platform of Waste pre-treatment and production of alternative fuels for CBR Lixhe (Liège) cement plant.
Day 3: 8 March 2023	
09:30 - 16:00	AM Symevad (France) Visit
Day 4: 9 March 2023	
09:30 -12:00	Platform of Waste pre-treatment and production of alternative fuels, Geocycle Seneffe
12:15 – 13:45	Lunch Break
14:00 – 15:00	Presentation of +/- 1 hour on Holcim's Go4zero project (new Kiln with >90% AF and CCUS by oxyfuel).
15:00 - 16:30	Visit to Obourg Plant

4.4 Summary of Presentations

Presentations were delivered by host facilities and facilitator. The presentations outlined the objective of the benchmarking program and purpose of the exchange visit, description of each facility, application of the RDF use in cement plants and Waste pre-treatment and production of alternative fuels and a similar application in Europe.

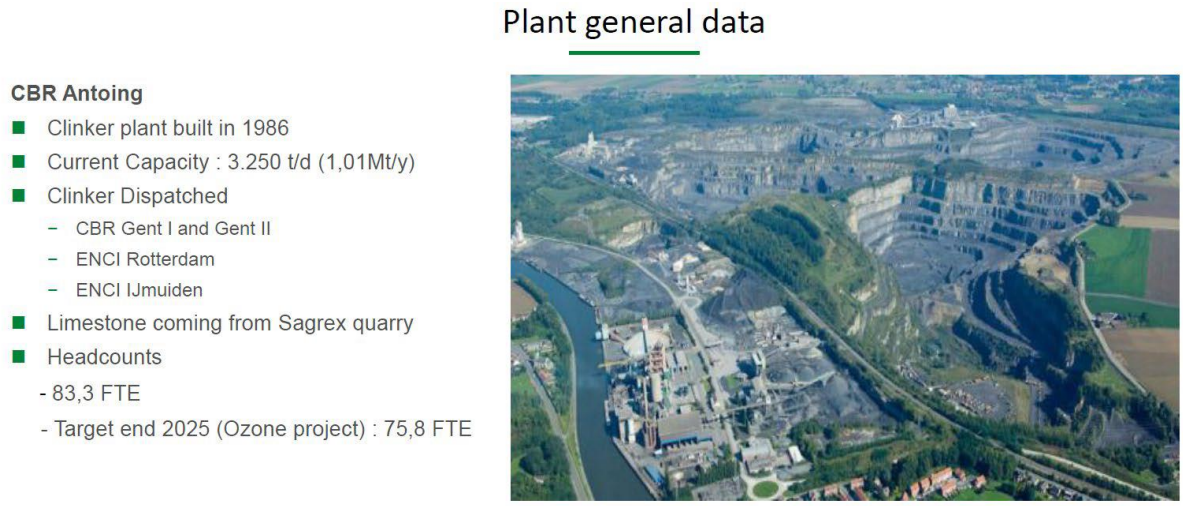
5. Visit Details

Diverse exchange topics and various organizations were selected to showcase their projects addressing the exchange topics of the visit and discuss sustainable developments and achievements in utilizing AF/RDF waste as fuel as described hereafter.

5.1 Antoing Cement plant visit

During the visit to the CBR Antoing Cement plant in Belgium, the delegation met and held a briefing meeting with Mr R. JANUS, Plant Manager HM Antoing who present us with plant general data, process, mass flow and technical aspects as well as the Kiln upgrade project. He also provide us with useful information on the AFR increase rate mainly biomass leading to the CO2 reduction. The delegation was further informed that HEIDELBERG CEMENT GROUP is developing new in-house pilot concept project of hybrid technology combined Oxyfuel&Amine process.

In fact, Antoing Cement plant belongs to the HEIDELBERG CEMENT GROUP based in Belgium with Clinker plant built in 1986 and Current Capacity: 3.250 t/d (1,01Mt/y). The plant is recently upgraded production line with already low CO2-emissions due to 70% alternative fuel usage retrofitted with hybrid system with 97% capture efficiency. It is the first carbon free inland cement plant in western Europe fully meeting the climate objectives of Belgium and the European union.



Process and technical data: clinker production

- 5 stages preheater: tower with pre-calciner (Technip-Clé)
- Nominal design capacity 2.600 t/day, upgraded to 3250 t/day
- Rotary kiln (67 m –diam. 3.9 m)
- Grate clinker cooler (Claudius Peeters / revamped by IKN)
- Chlorine bypass (8%)
- Bag filter (installed in 1999)

Alternative Fuel applications

Process and technical data: Fuels –AFR = 68% -More than 160 000 To/year. With Coal as main traditional fuel+ an extended set of various alternative fuels

Main burner (35 % of total energy)

- Alternative Rate: 50 –55 %
- Greco main burner installed in 2010
- Main fuel: coal
- Alternative fuels: Animal meal
    - Pellets: New installation started in 2010
    - Dried sewage sludge: new installation (ATEX) started in 2010
    - +O2 injection

Calciner (65 % of total energy)

- Alternative Rate: 75 –80 %
- Main fuel: coal
- Alternative fuels:
    - Plastics 3D
    - Saw dust
    - Pellets
    - Animal meal
    - Dried sewage sludge (ATEX)

Photo: By Stephane P.

5.2 Lixhe Cement plant visit

The second day of our exchange program was dedicated to visit CBR Lixhe Plant and Recyfuel Pre-Treatment Platform. The visits accorded the participants the opportunity to interact among themselves and continue with the technical lessons learned and Capitalising on international knowledge.

The team first visited the CBR Lixhe Full integrated cement plant where participants interacted with the staff and had a firsthand experience with LEILAC project (Low Emissions Intensity Lime and Cement). The delegation was therefore provided the following information:

CBR Lixhe

CBR Lixhe – general overview

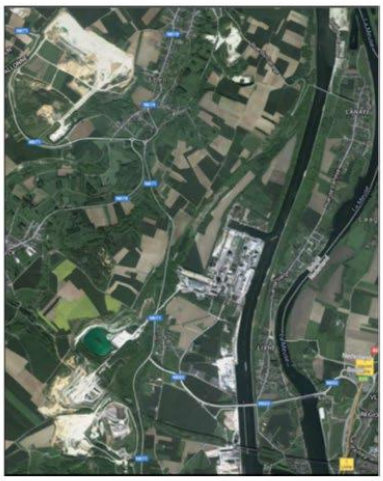
Started in 1950 with wet kilns – 200kT/y
- 1974 : First dry kiln in parallel with wet kilns
- 2001: Revamping of dry kiln to increase production and stop of the last wet kiln

Design capacity :
- Quarry: 2,7 MT/y Limestone + 1,1 MT/y overburden
- Kiln E: 1,4 MT/y
- Cement: 1.5 MT/y

Expedition cement:
- 12 qualities: CEM I; CEM II; CEM III; N; R; LA; HS + HRB STAB20/CBR26
- Expedition in bulk truck, bulk boat
- Expedition in paper or plastic bags + big bags campaign when needed

People: 179 FTE (post RZ 2017 – vision Ozone 2027-169 FTE)

Our customers :
- Domestic markets: ± 1.350.000 tons cement
- Clinker : ± 480.000 tons clinker (HC Bene: Gent, Ijmuiden, Rotterdam)



- Fuel: substitution of coal (primary fuel): 65-70 % Valorization of 300.000 tons/year of waste (including biomass fraction).
- Ongoing sustainability projects are:
  - Renewable energy: solar roof top project
  - New technology to recycle concrete.
  - Capturing unavoidable carbon emissions in the cement and lime industry

Photo: By Stephane P.

5.3 Recyfuel Platform visit

After a short Lunch Break, the delegation moved on to visit Recyfuel Platform of Waste pre-treatment and production of alternative fuels for CBR Lixhe (Liège) cement plant.

In fact, Recyfuel Platform Established in 1986. Production of 2 substitute fuels, physically and chemically homogeneous. From physically and chemically heterogeneous hazardous waste, and sawdust/absorbents to replace coal.

- Nature of the waste

Paint, ink, glue, resin oily sludge, tar, grease reaction and distillation residues soap, detergents, cosmetics filtration earth and cakes, petrochemicals packaging and contaminated materials

- Physical aspect of the waste

liquid, pasty, sludge, solid (powder, blocks, …), pre-impregnated/shredded product, hazardous packaging, contaminated materials

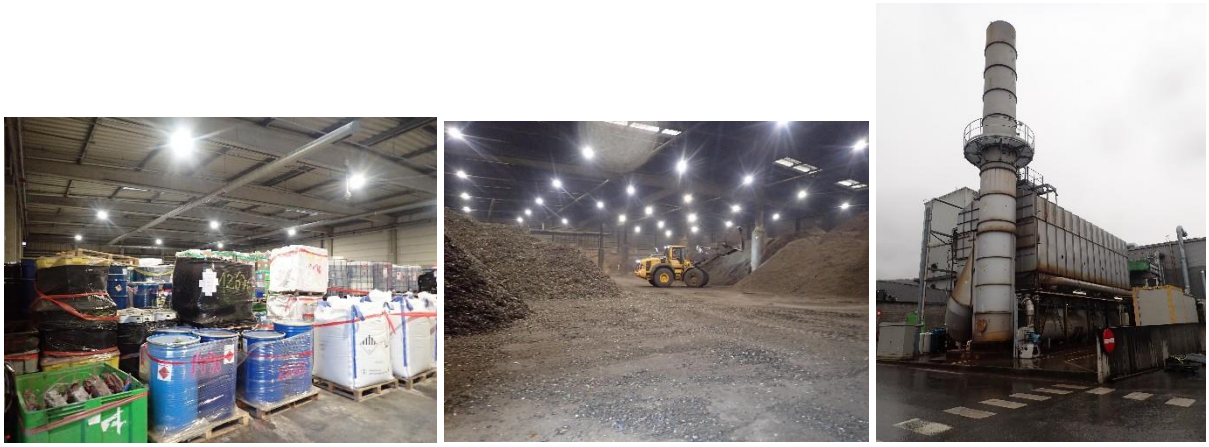


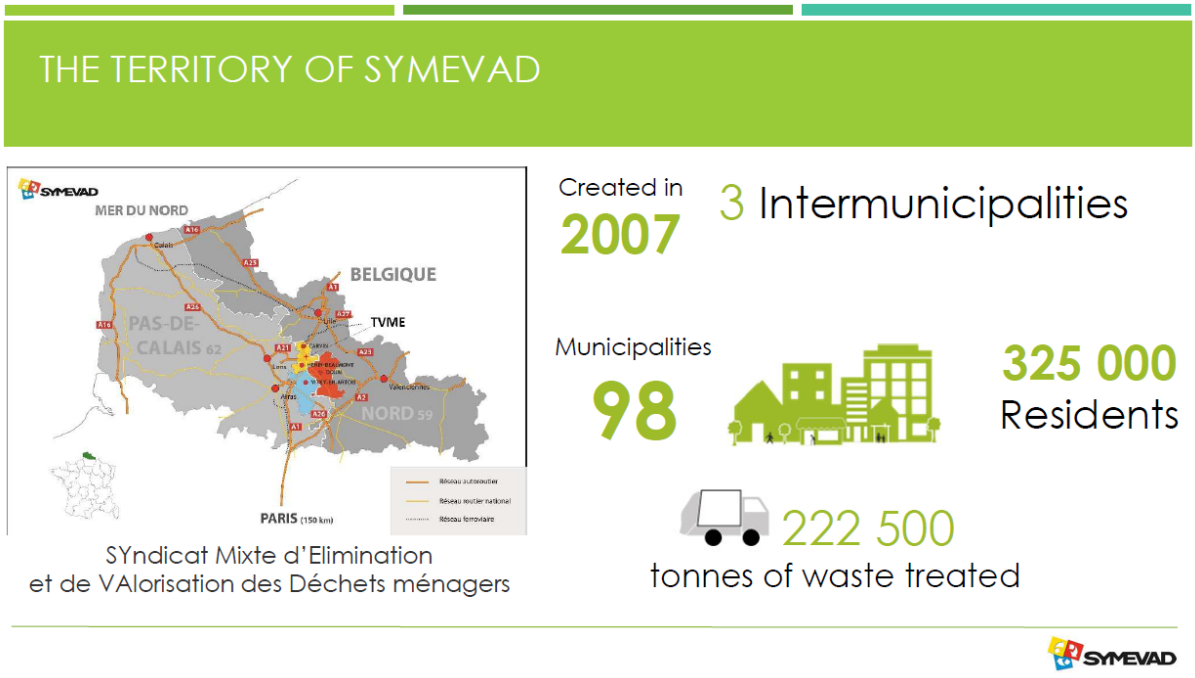
Photo: By Stephane P.

5.4 Symevad (France) visit

The next stop was the Joint Syndicate for the Elimination and Recovery of Household Waste, SYMEVAD of the Agglomeration Communities of Douaisis, Hénin-Carvin and the Community of Osartis-Marquion that brings together 98 communes or 325,000 inhabitants.

Mr. Musial, President of SYMEVAD was able to explain to Mr. Godana Tarekegn Bululta - Minister of State at the Ethiopian Ministry of Industry and his delegation, the strategy of SYMEVAD in terms of waste management. Subsequently, Sophie Dupont, process engineer, carried out the technical visit to TVME, the unit in charge of the treatment of household waste on our territory, it allows them to be transformed into town gas and CSR. A unit operated by SUEZ.

It was established in 2007 by three interminability with the objectives of communication and waste reductions, waste treatment and sales of renewable energy with an investment of 80 million euros over 10 years: 2008 / 2018. SYMEVAD has been able to deploy new innovative recovery units to transform the 213,000 tons of waste collected into new resources and green alternative fuels to fossil fuels. The territory has a packaging sorting centre, a Material Energy Valorization Sorting (TVME) unit for residual household waste, a plant composting centre to give a second life to bulky items and a network of recycling centres.



Unité de Tri Valorisation Matière Energie (TVME) à Hénin-Beaumont (62)

- Treatment of non-recyclable residual waste
- Production of biofuels :
  - → Solid Recovered Fuel (SRF) used by cementworks
  - → Biomethane injected into the public natural gas grid – bio-natural gas(GRDF)

Key figures

- Capacity : 80 000 tons / year
- SRF : 25 000 tons / year
- 2 400 000 Nm^3 of biomethane
- Energy potential produced : 115 millions de kwh/year
- 40 persons

With the financial support of

SYMEVAD

Treatment of non-recyclable residual waste

- Production of biofuels:
  - Solid Recovered Fuel (SRF) used by cement works.
  - Biomethane injected into the public natural gas grid – bio-natural gas (GRDF)
- Capacity: 80,000 tons / year
  - SRF: 25 000 tons / year
  - 2,400 000 Nm3 of biomethane
  - Solid Recovered Fuel (SRF)

  - Biomethane injected into the public natural gas grid

Photo: by Stephane P.

5.5 Geocycle Seneffe Platform visit

In the last day of the schedule, A visit to a waste processing and management plant, Geocycle platform was conducted in the area. In fact, the plant treat and prepare different kind of alternative fuel in order to supply Holcim Obourg plant with the alternative fuel it requires.

The different type of raw materials used for the preparation of alternative fuels are described in the following table:

 *Bemti*	Semi-solid non-hazardous and hazardous sludges, from water treatment installations, (Filter cakes, centrifuge sludge)
 *Cobex*	Slag from the metallurgical sector, bottom ashes, lime fractions (free of carbonates) which can be driedinto powder in the Cobex installation
 *Pit material*	Thick pasty sludge's: Oily waste or hydrocarbons, paint, ink, varnish or silicon waste. Sludge from material processing, waste which contains solvents,
 *Impregnated sawdust*	Wood dust and/or sawdust which is released during the reduction, treatment and sifting of (waste) wood. PU dust which is released during the recycling of refrigerators and the production of insulation materials.
Secondary Raw materials (MPS)	Sludge's and powders containing Al-, Fe-, Si- and Caoxides.
 *Solvent*	Tank bottoms, non-generable waste oil, residue of solvents, paint, liquid distillation products,…
 *SRF*	SRF coming from the treatment of waste
Viscous solvent	Residue of solvents, paint and mineral oil with the following origin: Heavy hydrocarbons, cracking residue, residue fromviscous distillation,…

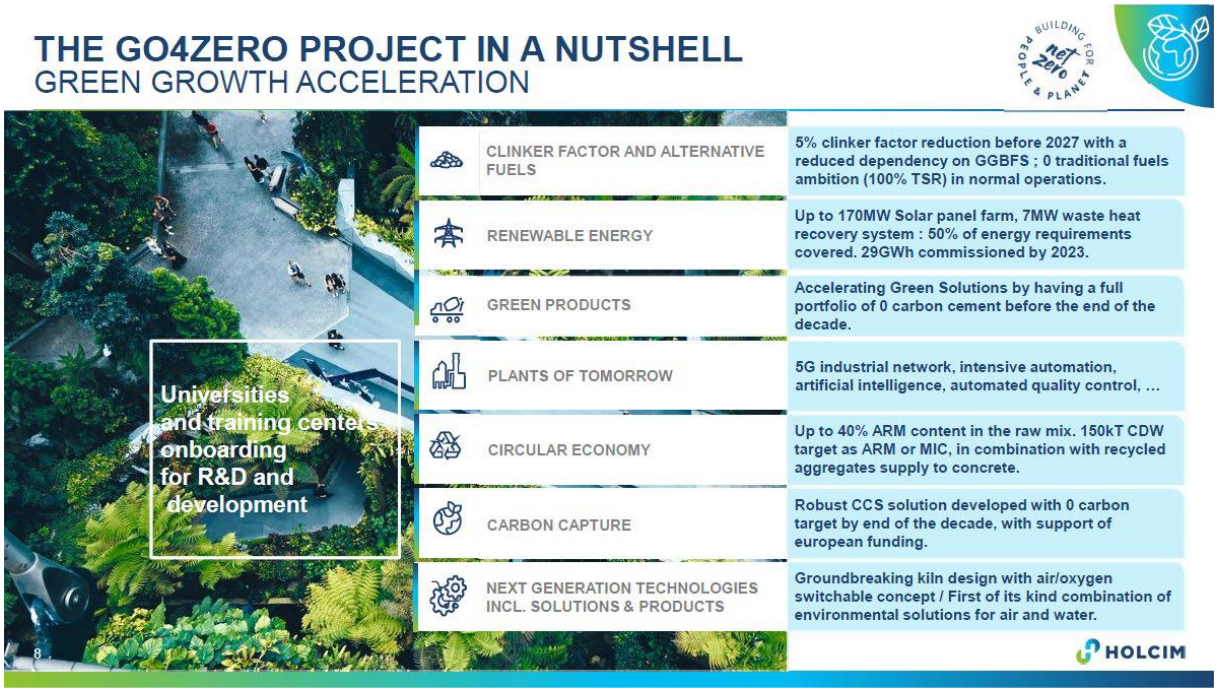


Photo: by Stephane P.

5.6 Obourg cement plant (Holcim) visit

During this visit, the delegation was given insight into the Alternative fuel use in Holcim Oubourg cement plant, with a Presentation of The Holcim's Go4zero project by constructing a new dry process clinker kiln that uses oxygen instead of air and more than 90% AF in the combustion process and carbon capture installation project, in order to achieve carbon neutrality at the plant by 2030. The presenter says that the plans involves establishing a new 135m-high cooling tower, instead of a 145m-high tower as previously planned.

The delegation later embarked on a guided tour within the cement plant and also had an opportunity to observe specific process and feeding system using more than six sources of alternative fuel in the kiln.



Working towards the following targets:

- as of 2029, 1'030kt co2 sequestered, inc. 70kt non-biogenic co2, out of 1'130kt emitted for a yearly clinker production of 1,400kt. oxyfuel and carbon processing unit in the heart of the innovative process.
- Air-Oxygen switchable 4, 500Tpd capacity kiln ready by Q4, 2026 with full capacity and carbon neutral by 2029 using a mature CCS value chain with more than 1mT CO2 /y storage.

6. General Observations and recommendations

Having finalized the detailed visit in Belgium, each exchange visit served as an intensive field practicum for the participating group and The Benchmarking and knowledge visit accounted for a couple of observations and recommendations, which could serve as the main learning outcomes and are therefore mentioned below:

- It was quite revealing to see the level of work already accomplished by the cement plants to use alternative fuel in their process within a high rate achieving more than 80% as a combustible in potential cement plants.
- In fact, Belgium has been one of the early adaptors in co-processing. As a result average substitution levels are high at 52.6% and there are a few barriers to co-processing due to political and societal acceptance. Main concerns are competition with WtE plants, future biomass availability and fiscal barriers between regions.
- There is no technical limitation at the cement plants to increase the share of alternative fuels from 36% now to 95% EU-wide. However, it will require investments for the cement industry. These costs can be covered by a gate fee. However, the willingness and ability to pay for advanced waste treatment varies per country, largely depending on the economic situation.
- Therefore, the expansion of co-processing in Ethiopia could be possible if such recommendations will be seriously considered:
  - → Strong commitment of the cement sector, including through: grasping the alternative fuel market opportunities as they were emerging; establishing mid-term and/or long-term contracts with the waste management sector; smart and continuous investments in the handling (and in some cases preparation) of alternative fuels; and the development of skills in kiln operation to accept low-quality alternative fuels.
  - → Ongoing enforcement of waste regulations, particularly those related to landfilling.
  - → A favorable economic context comprising smart national and international investments, taxation on landfilling, and some alternative fuel opportunities supported by European subsidies.
- Also, it was a great opportunity to observe the first achievement in France inspired by German feedback and experience, SYMEVAD, a Public Establishment for Intermunicipal Cooperation bringing together three local authorities which covers 82 municipalities for a population of 307,350 inhabitants, the model was based on a proactive policy of recovery of household waste collected throughout its territory. It has built a new material recovery sorting unit that is particularly efficient in terms of energy recovery. Avoiding incineration or burial, it produces both solid recovered fuel and biogas. Today, we no longer speak of a waste incineration plant but of a Material and Energy Recovery Sorting Unit (TVME). Furthermore, the cost of treatment is kept at a reasonable level for the future. The environmental approach is also exemplary for the design of the unit, the maximum prevention of nuisances (odors, effluents) and local energy recovery channels.
- It was a good experience to get to know, that the actors were able to commit to this process mainly because they managed to create a sufficiently large structure (at least

250,000 inhabitants) to access the best technologies in terms of waste recovery and treatment.

- It was noted that the different illustrative examples has shown that this pooling of resources, incentives and regulations allow the communities and private sector to put in place a complete and effective system aimed at maximum waste recovery while integrating a proactive approach at the High Environmental Quality and Sustainable Development level.
- At a glance, Belgium Waste Management Showing good performance and the waste market is advanced, well established and internationally integrated due to the following drivers:
  - → Plants have the permits to operate with higher co-processing rates and are technically ready for increased waste uptake
  - → Increasing cost of fossil fuels and of waste disposal can lead to further AF uptake in the sector
  - → The need to reduce GHG emissions will lead to increased use of waste biomass
  - → Waste management in Belgium falls under the responsibility of the three regions: Brussels, Flanders and Wallonia, waste management policy and law are developed by these three separate entities.
  - → EU Directives on Landfilling and Waste have been adapted national and regional law.
  - → All three regions have separate MSW waste stream collection
  - → The three regions have different tax rates for waste treatment, with Flanders having supportive tax rates for the WtE sector
  - → A nationwide landfill ban of untreated waste, including biodegradable municipal waste, has been in place since 2007.
  - → There are plans to establish advanced Waste to Energy, Biomass to Energy and even waste to chemicals plants in Flanders
- It is recommended that the Government should regard co-processing in cement as ‘better than’ option, due to material recovery of ashes and energy efficiency aspects. Also, Provide more fiscal incentives for waste use and tax exemption for the use of hazardous waste and Secure Biomass availability and sustainability for the cement industry
- Finally, these results and achievements are promising, but they require the prior implementation of strong communication and awareness-raising actions.

7. Conclusions

The benchmarking visit was worthwhile and provided an avenue for a lot of lessons learnt and consolidation of best practices within the European and Belgium market. The important thing is for both Countries to implement what was learnt and shared. Such visits should be encouraged even in other projects as they can contribute to efficient and effective implementation of projects. Much of what is required now is to set the pace for the implementation of these practices within the Ethiopian context.

This exchange program showed that co-processing of waste in cement kilns is already being widely employed across the EU, but that the potential for further uptake is still large.