Policy Brief: Prospects for Energy Efficiency in Uganda Cement Industry

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Cement production is highly energy intensive – and Uganda's cement demand is growing rapidly. How can energy efficiency help reduce costs, ensure the sector's positive contribution to economic growth and mitigate greenhouse gas emissions? We provide insights from a participatory research project conducted together with local partners and including energy systems modelling.

Key messages and recommendations

- In Uganda, over the next two decades, the demand for cement is projected to grow by 7% a year. Hence, enegy demand from cement factories is projected to increase by 300%. Policies that promote the deployment of energy efficient technologies would result in significant decrease in energy demand and greenhouse gas emissions from the sector – while ensuring its positive contribution to economic growth.
- The (Draft) National Energy Policy sets out a plan to promote energy efficiency among high energy consumers. Once the policy is adopted, efforts must focus on building capacities and developing tangible incentives.
- Updating and legislating the Energy Efficiency and Conservation Bill (2010) is important to the establishment of institutions that can support and stimulate efficiency in energy management.
- In the meanwhile, regulators should encourage industries to reduce 'process emissions' from industrial activities by defining specific goals for specific processes based on negotiated agreements with the sector stakeholders and best practice as benchmark targets.

Research background and motivation

The cement industry is one of the world's most energy-intensive industries. The sector contributes about 7% of the global anthropogenic CO2 emission, and about 60% of the greenhouse gas (GHG) emissions are attributed to 'process emission' that happens during clinker manufacturing.[i] Sub-Saharan Africa has only a small share of the world's cement consumption, with an average yearly per capita of 109kg per person, much lower than the world average of 550kg per person in a year.[ii] In Uganda, it is estimated at less than 120kg per capita. However, production has gradually increased to meet growing domestic demand and export to neighbouring countries. Demand for cement is expected to grow at 7% per year in Uganda, and production is projected to increase from the current 2.9 million metric tons (MT) to 11 million MT by 2040.

In Uganda, there are two types of cement manufacturing industries: integrated cement factories, which account for about 70% of total cement production, and grinding mills, which accounts for 30% of the total output. Grinding mills import clinker and add value (grinding and packaging), whereas integrated cement mills carry out the full production process: from raw material mining to pyro-processing and finishing. In 2019, the sector accounted for over 13% of Uganda's total industrial electricity demand.

Uganda's current average energy intensity of its cement industries is about 3.78 GJ/ton of cement. Based on the estimated increase in production and assuming current technologies and operational practices are maintained in the next two decades, the sector's energy demand will increase by over 300%. Furthermore, currently, the emission intensity is 0.13tCO2/ton of cement. This is much lower than the global direct GHG emission intensity of 0.54tCO2eq/ton of cement. This is because most mills use biomass as a fuel (55% biomass). However, this GHG intensity too is expected to increase by over 250% by 2040 as demand for and production of cement increase.

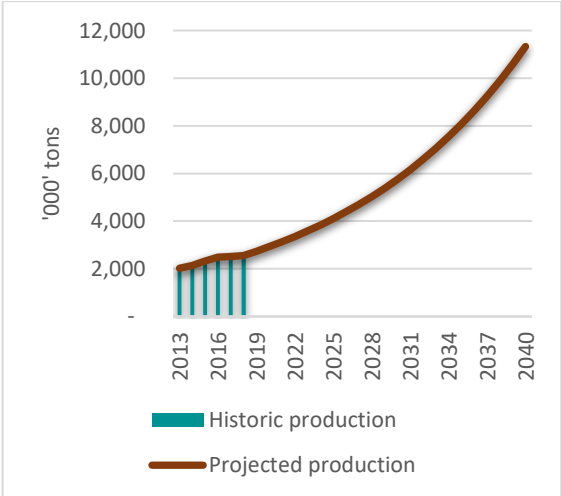

Figure 1. Cement production projection in Uganda (UBOS, 2019)

About the study

As part of an EEG funded project (Institutionalization of Energy Efficiency in Uganda), this policy brief discusses findings from a scenario-based analysis to explore the future energy demand and associated GHG emissions from the cement sector. The study uses the Low Emissions Analysis Platform (LEAP) modelling tool. The impact of different energy policies is analyzed by considering two scenarios. The first is best practice with current technologies (BPT), i.e. localized energy efficiency options derived from retrofits and equipment servicing. Under this scenario, we included sub-scenarios depicting efficiency enhancement in each sub-process (e.g. impact crusher, air fluidized homogenizer, ball mills, vertical roll mill etc.). Best available technologies (BAT) refers to a scenario where facilities (gradually) transition to the best efficient production system. The sub-scenarios under this category include process streamlining induced by significant technology investment.

Results and discussion

Energy demand and energy saving potentials: In the next two decades, the gradual transformation of Uganda's economy and the associated urbanisation will result in a growing demand for cement and a steady increase in energy consumption and associated GHG emissions. Based on our estimation, growth in cement production would result in final energy demand rising from 7,267TJ to 30,000TJ by 2040. However, our analysis shows that with best practices (efficiency improvements and equipment servicing), the sector's annual energy saving potential is 8% and as high as 20% if mills adopt the 'state-of-the-art' technology.

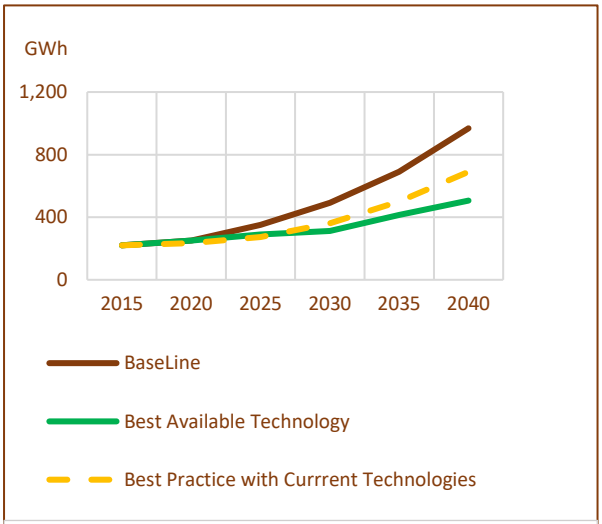

Figure 2. Cement sector energy consumption projections

Similarly, we also observe a considerable jump in energy savings opportunities under the BAT scenario regarding electricity consumption. In 2020, a total electricity consumption of 285GWh was reported for the cement industry. This represents 9% of total national electricity demand and 13% of total industrial sector demand. Without any intervention, the steady rise in cement production would result in a 280% increase by 2040, i.e. the level of elecricy consumption for the sector would reach 1,100GWh. Our analysis shows that with best practice with existing technologies (improvement in energy management), the sector could save up to 250GWh, whereas a gradual transition to state-of-the-art technologies would result in a saving of 500GWh.

Greenhouse gas emission: In Uganda, the emission intensity in the baseline scenario is 0.13tCO2 per ton of cement. This is much lower than the global direct GHG emission intensity of 0.54tCO2 per ton of cement. One reason for this is that mills in Uganda mostly use biomass as a fuel. However, our projection shows that it can be even lower under BPT (0.098tCO2 per ton of cement) and BAT technologies (0.089tCO2 per ton of cement), respectively by 2040. In 2020, the sector's overall GHG emission was 210ktCO2eq. By 2040 this is expected to increase by 290% (to 813ktCO2eq). However, our analysis shows that GHG emission avoidance due to the adoption of state-of-the-art technologies could lead to an annual saving of 109.2ktCO2eq by 2040.

Process emission: In cement production, about 60% of the GHG emission is attributed to 'process emission' during clinker manufacturing. A targeted efficiency improvement approach to specific aspects of the production process (finishing and material preparation) presents high energy saving opportunities. Replacing existing ball and vertical roller mills with advanced horizontal high-pressure roller mills could also yield a cumulative energy saving of 8,175TJ. Other least cost actions include implementing energy efficiency in pyro-processing kilns, efficient impact crusher, and transitioning to modern kilns. Making these adjustments would yield a cumulative saving of about 35,000TJ at 0.7 USD/GJ, 2.7 USD/GJ, and 5 USD/GJ, respectively.

Policy implications

The cement industry in Uganda is not a major emitter. However, demand is growing, and production is projected to increase significantly over the next 20 years. Investing in key energy efficiency management strategies such as switching to lower-carbon fuels and promoting material efficiency presents economic and energy-saving opportunities and reduces carbon emissions in cement production. Hence, any policy and regulatory intervention in this area should aim to reduce GHG emissions, increase energy-saving opportunities, and ensure the sector plays a significant role in Uganda's economic development.

The Uganda National Energy Policy (2002) sets out a plan to promote the efficient utilisation of energy resources. As part of this commitment, the Ministry of Energy drafted the National Energy Efficiency Strategy (2010–2020) for all sectors, including industry. The document paved the way for drafting the Energy Efficiency and Conservation Bill (2010). The Bill provides the statutory basis for the promulgation of rules and regulations to promote energy efficiency. It defines the rationale for pursuing energy efficiency and lays out an overall strategy to achieve them. Updating and adopting the Bill is a critical next step. The presence of an enabling statutory basis is important for establishing energy efficiency institutions.

The (Draft) National Energy Policy (2021) also sets a policy agenda to promote energy efficiency across all sectors. Some of the associated strategies include promoting the implementation of Energy Management Systems (EMS) and regulating energy usage among high energy-consuming industries. Currently, in draft format, the policy needs to be adopted and operationalised. Doing so would pave the way for developing other policy instruments (administrative mechanisms and market-based incentives) to promote cement firms' compliance and deployment of efficient technologies.

Efforts to mitigate climate change and reduce global GHG emissions must include energy efficiency strategies. In this regard, as demonstrated in the case of the cement industry in Uganda, uptake of energy efficiency measures could reduce industrial energy use. However, currently, the role of industrial energy efficiency as an opportunity to reduce GHG emissions is underrated. As a result, it is not receiving sufficient attention from climate mitigation and adaptation perspectives. Embedding (industrial) energy efficiency in national climate policies and strategies could unlock innovative partnerships and financing mechanisms toward integrated solutions designed to address the challenges of energy, climate and development.

In this regard, research projects like this one also create opportunities on multiple fronts. On the one hand, the collaborative process enables stakeholders from the industrial sector and public institutions to come together and identify opportunities and barriers. On the other hand, the knowledge produced and the analysis that come out of such exercise provides the input policymakers need to take the necessary step to create an enabling environment. One such example comes from our own research experience. As part of our ongoing engagement with public institutions in Uganda and following our sharing of the findings, the Ministry of Finance, Planning and Economic Development has included the cement industry in its Sustainable Public Procurement National Action Plan in 2021 with the objective of using the Government's buying power to influence best practices in the sector.

This shift in policy is a significant step toward incentivising industries to improve efficiency. To augment this and as a next step, policymakers can define specific goals for specific processes or sectors to reduce 'process emissions' and encourage a more targeted approach. Such policy measures can be developed not to prescribe specific actions but to promote the use of energy management processes. This would allow industries to have some discretion in dealing with technical suitability and cost-effectiveness matters.

[i] IEA (2021), *Cement*, IEA, Paris, France. https://www.iea.org/reports/cement
[ii] UBOS (2019), Construction, Kampala, Uganda https://www.ubos.org/wp-content/uploads/publications/11_2020STATISTICAL__ABSTRACT_2020.pdf

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