Project LIME:

Laos Initiative for Managing Concrete Emissions

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1. Problem Identification

1.1 Defining the problem

Concrete is inescapable in our rapidly urbanizing world, second only to water in global usage.[1] This poses a significant environmental concern given that cement, the binding agent in concrete, contributes around 8% of global greenhouse gas emissions.[2] In perspective: If the cement industry were a country, it would be the third-largest CO2 emitter. In order to meet the targets set by the Paris Agreement, the cement industry would need to cut down its annual emissions by at least 16% by 2030.[3]

Initial efforts to cut concrete-based emissions have been founded in seeking alternative building materials, but have culminated in disappointing results. More sustainable materials such as bamboo and rammed earth have been explored, but none have matched the scalability, durability, and structural performance required for widespread use in modern infrastructure and development.[4] Solving concrete-based emissions, then, requires going directly to the source of the emissions.

This project aims to do just that, proposing cement co-processing and Environmental Product Declarations (EPDs) in Lao PDR (hereafter referred to as Laos) as a potential step toward lessening concrete-based emissions.

1.2 Laos

As a Least-Developed Nation (LDC) seeking to enter middle income status by 2030, Laos is a nation with rapidly growing concrete needs. One illustration of this is the country's investment in dam construction.[5] Positioned as one of Asia's largest exporters of hydroelectricity, the nation is now taking steps towards becoming the "battery of Southeast Asia" through energy exports.[6] The country has

[1] Winn, "Cleaning up One of the World's Most Commonly Used Substances." MIT Office of Sustainability.

[2] "Concrete Needs to Lose Its Colossal Carbon Footprint." *Nature* 597, no. 7878.

[3] Akinrebiyo, "This New Decarbonization Tool Is Helping Cement Manufacturers to Become Greener and More Efficient." World Bank Blogs.

[4] Pritchard, Jim. 2023. "Bamboo vs. Concrete: The Pros and Cons of Building with Each - Building Renewable." Building Renewable. March 9, 2023. https://buildingrenewable.com/bamboo-vs-concrete-the-pros-and-cons/.

[5] Inoue and Onishi. "Southeast Asia's 'battery' Laos Embraces Wind Power to Sustain Energy Exports." Nikkei Asia.

[6] Inoue and Onishi. "Southeast Asia's 'battery' Laos Embraces Wind Power to Sustain Energy Exports." Nikkei Asia.

already broken ground on the third of eight planned mega-dams on the mainstream of the Mekong River,[7] a heavily concrete-reliant project that is still in its early stages. These efforts run parallel to Laotian urbanization as well as rebuilding efforts following the many natural disasters the country is prone to.[8] All these factors come together to demonstrate the growing concrete demand in Laos and how it can only be expected to grow in the coming years.

Beyond the contextual factors driving concrete usage, Laos' growing concrete needs are visible in the country's imports on materials used in cement production. April 2021's import costs of $8.47 million USD more than doubled to $17.25 million USD by October 2023 (Figure 1).[9] Through this increased investment in concrete materials, Laos has been able to progressively increase cement production year by year, growing from 1.5 million tons in 2013 to 3.4 million tons in 2017.[10]

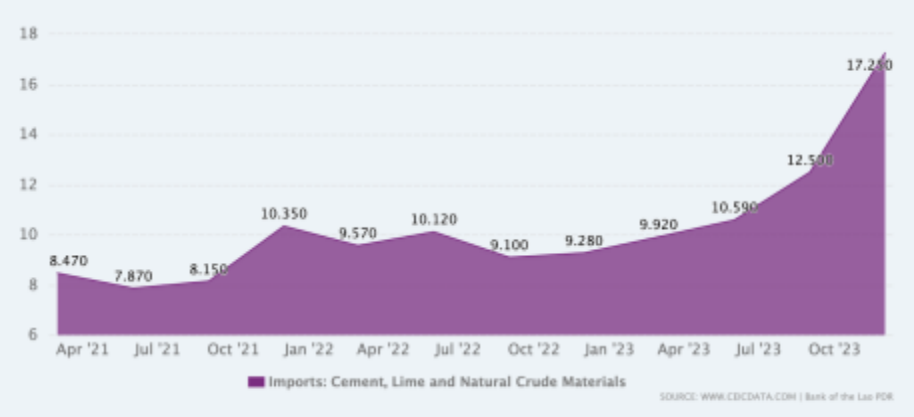

Figure 1: Laos' imports on materials used in cement production (million USD)

However, while increased cement production is spurring Laos' development, it is also increasing greenhouse gas emissions.[11] Looking at the country as a whole, Laos' 2023 CO2 emissions of 24.8 million

[7] Strangio, Laos takes another step forward on controversial mekong dam

[8] "World Bank Climate Change Knowledge Portal," Mean Projections Expert I Climate Change Knowledge Portal

[9] "Laos Imports: Cement, Lime and Natural Crude Materials." CEIC.

[10] "Laos Has Been Imported Cement for Higher Domestic Demands in the Last Six Months." Trade Information Portal.

[11] Ritchie, Roser, and Rosado, "Laos: CO2 Country Profile." Our World in Data.

tons[12] is projected to reach a massive 111 million tons by 2050,[13] a 347.6% increase. Zooming in, it is clear that cement production plays a significant role in these emissions. With rapid growth since the 1950s, cement-based CO2 emissions catapulted from an estimated 820,000 tons in 2013 to 5.5 million tons a decade later in 2023,[14] accounting for 22% of all CO2 emissions in that year. Moving into the coming decades, these emissions are expected to continue on this trajectory.

Laos' emissions trends are concerning as cement-based emissions are uniquely problematic. Cement plants emit CO2 from a single concentrated source rather than being dispersed over larger areas, contributing directly to air pollution in the communities surrounding cement plants.[15] Every year in Laos there are 10,000 deaths attributed to environmental health risk factors (21.6% of all deaths in the country), and air pollution alone represents 44% of those deaths.[16]

In addition to air pollution, Laos also grapples with significant waste mismanagement, specifically regarding disposal and segregation at the source[17] [18] (a relevant factor to the co-processing prong of this project's proposed solution, detailed in section 2.2.1 of this proposal). With no comprehensive waste

[12] ICEM. Lao PDR: Analysis of available air quality data and potential sources/sectors and identification of promising air quality measures.

[13] Technical Recommendations for Lao People's Democratic Republic Long-Term Low-Emission Development Strategy, World Bank

[14] ICEM. Lao PDR: Analysis of available air quality data and potential sources/sectors and identification of promising air quality measures.

[15] ICEM. Lao PDR: Analysis of available air quality data and potential sources/sectors and identification of promising air quality measures.

[16] "Pollution / Lao People's Democratic Republic: Interactive Country Fiches." Pollution / Lao People's Democratic Republic | Interactive Country Fiches

[17] Huno, Borongan, and Keotiamchanh, (2024). Situation assessment report on the prevention of plastic and resin pellet leakage from formal and informal recycling facilities: Vientiane, Lao People's Democratic Republic.

[18] Waste composition data (Huno, Borongan, and Keotiamchanh, 2024) shows that organic waste accounts for 67% of total generation, followed by plastic (12.1%), paper/cardboard (8.8%), glass (3.3%), and others. At landfills, organic waste drops to 56%, while plastic rises to 27%, with paper/cardboard at 6%, textiles 3%, glass 2%, and other waste 6%. Recyclable plastics are often mixed with other waste, leading to poor recovery rates and low-quality recyclables.

segregation policies in place,[19] an estimated 90% of rural residents simply burn their solid waste to avoid the fees and logistical difficulties of utilizing local collection services.[20]

This waste mismanagement, in tandem with increased cement demand and environmental concerns, make Laos an ideal case study for this project.

1.2.1 Policy background in Laos

Now more than ever, countries across the globe are looking to be more green. This is demonstrated in skyrocketing investments into the industry, and The London Stock Exchange Group even found that the green economy now only has the technology sector ahead of it.[21] The fastest growing sector in this green movement is construction,[22] with many working to create novel opportunities for countries to participate in more sustainable construction practices. Beyond capital investments, however, countries are also implementing greener policies.

Recognizing the need to engage in the green transition, Laos has established three key frameworks to guide its path: the United Nations Framework Convention on Climate Change's Nationally Determined Contributions, 2025 National Socio-Economic Development Plan (NSEDP), and the National Green Growth Strategy 2030. The most updated iterations outline strategies for mitigation, adaptation and sustainable consumption and production patterns, focusing on resource efficiency, natural capital preservation, climate resilience, and sustainable urban and rural development into sectoral and local strategies. [23] [24] [25]

[19] Huno, Borongan, and Keotiamchanh, (2024). Situation assessment report on the prevention of plastic and resin pellet leakage from formal and informal recycling facilities: Vientiane, Lao People's Democratic Republic.

[20] Behavioral Insights to Reduce Open Waste Burning in Lao PDR, World Bank Group.

[21] Mittal, "Global Green Economy Now Worth $7.2trn, Second Best Industry Worldwide," edie

[22] "World Green Building Trends 2021." SmarkMarket Report

[23] Secretariat for Formulation of National Green Growth Strategy of the Lao PDR. "National Green Growth Strategy of the Lao PDR till 2030." Green Policy Platform.

[24] "Laos." Laos | NDC Partnership, August 15, 2024.

[25] Ministry of Planning and Investment. "9th Five-Year National Socio-Economic Development Plan (2021-2025)."

While acknowledging progress in institutionalizing climate commitments at global levels, Laos' current policy frameworks require considerable recalibration given that, despite being foundational to Laos' short- to long-term policies, they fail to address the carbon reduction potential of their concrete industry and broader embodied carbon issues of traditional construction materials. Despite 40% of emissions stemming from industrial processes, national 'decarbonization' efforts remain focused on operational fronts such as diversifying the green energy portfolio beyond hydroelectricity, and constraining opportunities in areas like reducing embodied carbon of traditional construction materials.[26] [27] [28]

While the National Green Growth Strategy promotes locally-sourced green materials like reclaimed wood and bamboo derived materials, and supports projects reducing operational emissions through solar power and natural solutions, it also does not address traditional construction materials, such as concrete, steel and aluminum. The National Socio-Economic Development Plan, for example, mentions the word "concrete" solely within plans for road expansion projects.[29] Additionally, existing legislation lacks explicit provisions for recovery, reuse, or recycling of materials for construction needs; handled predominantly by informal sectors, waste resources are left significantly underutilized.[30] [31]

Moreover, a senior official from the Department of Planning and Finance highlighted that the lack of standardized tools for integrated planning and cross-sectoral coordination significantly hampers the sustainable construction sector, not only in Laos but also in facilitating trade across Southeast Asia. Without unified systems for monitoring and regulation, Laos struggles to establish the reliability and transparency required to compete in the growing regional market for green construction materials, resulting in inadequate greenhouse gas monitoring and unreliable inventories, compounded by limited planning capacity, technical expertise, and external support. The official also emphasized Laos' potential to position itself strategically within the ASEAN region as a supplier of green construction materials,

[26] Kyophilavong, Souphonphacdy, Komany, and Tounalom. "Decarbonization in Lao PDR: The Options and Challenges."

[27] "Laos Commits to Decarbonization, Energy Transition." Laotian Times.

[28] "Sunlabob to Implement Rooftop Solar at World Bank Office in Laos." Eco Business.

[29] Ministry of Planning and Investment. "9th Five-Year National Socio-Economic Development Plan (2021-2025)."

[30] Ministry of Planning and Investment. "9th Five-Year National Socio-Economic Development Plan (2021-2025)."

[31] "Circular GHG Mitigation Opportunities Lao PDR." UNDP.

particularly to consumption-heavy countries such as Thailand, but noted that challenges lie in establishing comprehensive frameworks to certify and standardize the traceability of sustainable practices, not only in Laos but in other Southeast Asian countries as well. Addressing this gap could place Laos in an advantageous position, given its existing cement production capacity and geographic proximity, to expand trade opportunities and meet the rising demand for eco-friendly construction materials both domestically and in neighboring countries. Encouraging regional collaboration through shared standards and trade agreements could strengthen Laos' competitiveness while also promoting sustainable development across the ASEAN region with far-reaching effects.

2. Proposed solution

2.1 Solution requirements and objectives

Given the National Socio-Economic Development Plan's emphasis on "economic development as the central task", the demand for concrete will evidently remain significant.[32] [33] Amid competing priorities, Laos must balance its development needs with its commitment to net-zero by 2050 through a comprehensive policy that achieves all of the following objectives:

1) Incorporate concrete into the national decarbonization strategy: As it currently stands, there is a lack of clear direction in addressing concrete production at the national level in Laos. Given that concrete production contributes significantly to greenhouse gas emissions, and with Laos projected to increase production in the coming years, a successful strategy should integrate innovative and novel approaches to reduce both emissions and reliance on raw, virgin materials such as limestone and coal. Such an approach should be environmentally sound and approved by third-party organizations as a feasible solution.

2) Ensure cost-effectiveness and scalability in its operations: As a Least-Developed Country, Laos must prioritize solutions that are financially viable and easily replicable across the construction industry to avoid hindering its growth. This means the solution should not rely on overly complex or expensive methods, nurturing widespread adoption across the country. Additionally,

[32] Ministry of Planning and Investment. "9th Five-Year National Socio-Economic Development Plan (2021-2025)."

[33] "Architecture, Construction and Engineering Services." International Trade Administration.

as concrete companies are private entities, the solution must be economically beneficial, allowing for profitability. Incentivizing the market to produce more environmentally sound concrete and cement paves the way for cleaner and more sustainable practices, making Laos' development sustainable in the long term as well.

3) Formalize waste management to optimize resource use: Currently, waste management systems in Laos are underdeveloped, characterized by poor segregation practices, inadequate infrastructure, and reliance on informal operations. The absence of formalized systems to utilize waste in construction practices prevents efficient resource recovery, with recyclable materials often mixed with other waste, leading to poor quality and low recovery rates. Informal waste pickers, although vital for material recovery, operate without safety measures or fair compensation, limiting the scalability and sustainability of their contributions to waste management. Thus, a feasible solution should successfully standardize waste segregation policies at the source at the national level, integrate informal workers by transitioning them into formal roles through cooperation with private entities and training programs, safety initiatives, and structured compensation to improve both efficiency and livelihoods. It should also implement measures to reduce environmental and health risks associated with current practices, such as open waste burning and poorly managed landfills.

4) Providing policymakers with tools to realize sustainable construction practices: To support sustainable construction practices, policymakers require a comprehensive toolkit addressing greenhouse gas monitoring, intersectoral coordination, and decision-support systems. Effective greenhouse gas monitoring systems should provide real-time tracking of emissions throughout the construction lifecycle, supported by methodologies like Life Cycle Assessments (LCA) and other data collection methods to measure and benchmark sustainability performance over time. Decision-support system tools, such as Geographic Information Systems (GIS), Building Information Modeling (BIM), and artificial intelligence tools can guide decision-making by assessing environmental impacts, optimizing resource use, and simulating energy efficiency. Complementary practices include incentivizing compliance with certifications (such as LEED or EDGE), and investing in education and capacity-building initiatives for stakeholders across the construction value chain. In implementing these tools, intersectoral coordination among

government ministries, private entities, and communities will be vital in standardizing practices across sectors and promoting circular economy principles at the core of its efforts.

2.2 Proposal Overview

Our proposal comprises two complementary strategies: co-processing and Environmental Product Declarations (EPDs). In this section we will explain both in detail.

2.2.1 Co-Processing

First, we propose that the Lao government adopt co-processing as a greener solution for cement production. Co-processing involves the use of waste materials as alternative fuels and raw materials in the cement manufacturing process. Most waste, with the exception of batteries and other hazardous materials such as medical waste, can be utilized in the process after treatment (which typically involves drying and breaking down collected waste). Once treated, this waste is fed through a cement kiln, contributing energy to reduce the need for fossil fuels and substituting raw materials that would otherwise be necessary. This process is summarized in Figure 2.[34]

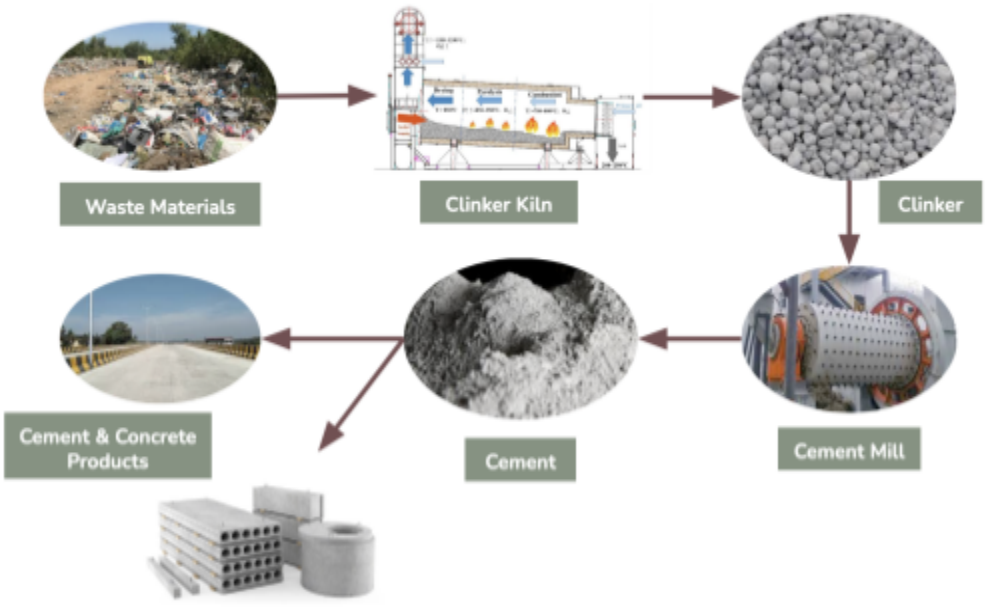

Figure 2: Working principle of waste material co-processing in cement kilns

[34] Mourshed, Masud, Rashid, Joardder. Towards the effective plastic waste management in Bangladesh: A review.

The most carbon-intensive stage of concrete production is the process emissions from clinker (binder) production, which accounts for two-thirds of cement emissions and results from the chemical reaction during limestone processing. Reducing the amount of processed limestone, as well as reducing the fuel used in the process is key, and co-processing ash residue from the co-processed waste offers an effective solution to the former problem. By doing so, co-processing in cement kilns recycles waste and reduces greenhouse gas emissions by recovering energy, (*Figure 3*)[35] decreasing coal use and primary material consumption, and addressing waste management challenges.[36]

Additionally, Laos' waste composition is well-suited for co-processing. Leveraging existing kilns, it requires minimal investment and eliminates reliance on incinerators and landfills without compromising concrete quality. Recognized by the Basel Convention as environmentally sound, co-processing will be promoted through regulatory measures and improved logistics to support its adoption in the cement industry.[37]

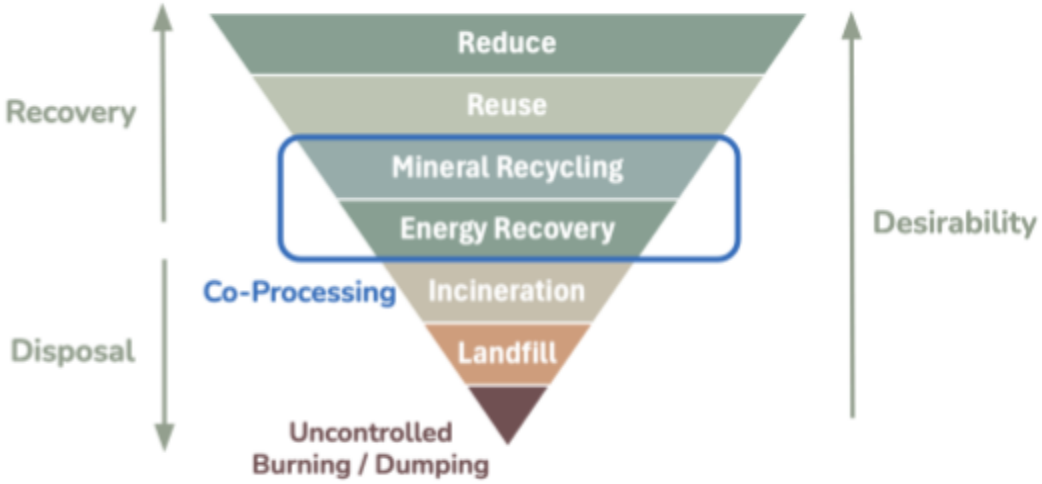

Figure 3: Conceptual Framework of Co-Processing

[35] Global Cement and Concrete Association. GCCA Policy Document on Co-processing.

[36] Global Cement and Concrete Association. GCCA Policy Document on Co-processing.

[37] Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes. Technical guidelines on the environmentally sound co-processing of hazardous wastes in cement kilns

2.2.2 Environmental Product Declarations (EPDs)

EPDs are standardized, verified labels based on Life Cycle Assessments (LCAs) and international standards (e.g., ISO 14025, ISO 14040/14044, EN 15804, or ISO 21930) that quantify and report embodied carbon and other environmental impacts, such as energy consumption and resource use, across all lifecycle stages of green construction materials–from raw material extraction to end-of-life. They enable effective greenhouse gas tracking and reporting by providing transparent, comparable data that supports sustainable decision-making in construction and helps reduce the carbon footprint of projects. (*Figure 4*)

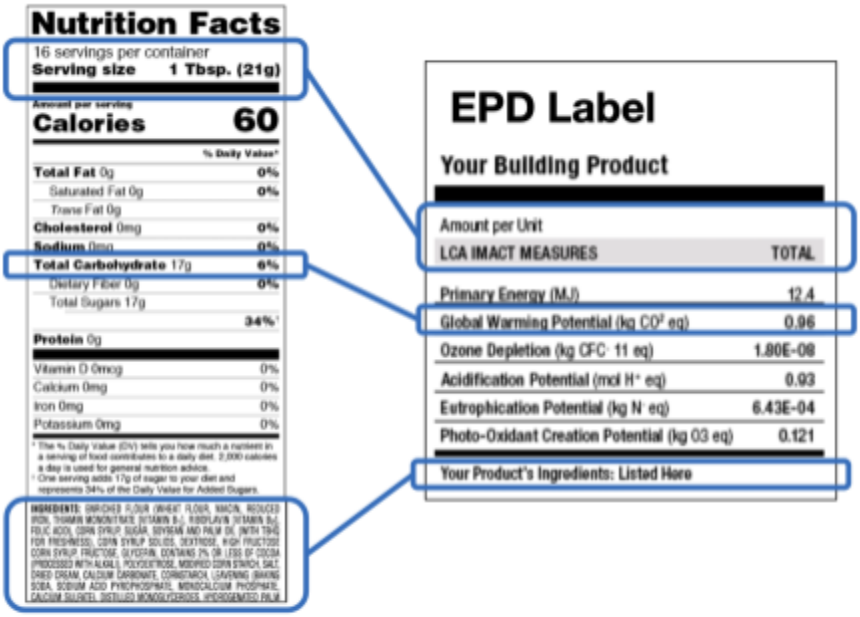

Figure 4: Comparison between a food nutrition label and a sample EPD

Properly implemented through specific steps, EPDs enhance data transparency and improve reliability of green materials. The cradle-to-grave (full life cycle of a product, from raw material extraction to disposal or end-of-life) impacts of concrete produced through co-processing will be accurately certified with EPDs, providing a foundation for transparent carbon accounting and promoting sustainable procurement practices.

We will utilize Building Transparency's[38] free, open-access tools for all stages of the EPD creation and registration process (*Figure 5*). Building Transparency is a nonprofit organization focused on reducing

[38] Accessible through https://www.buildingtransparency.org/

embodied carbon in construction through open-access tools such as EC3, Tally Life Cycle Analysis (LCA), openEPD, and openIMPACT, with a particular emphasis on supporting sustainable building practices in resource-limited developing countries.

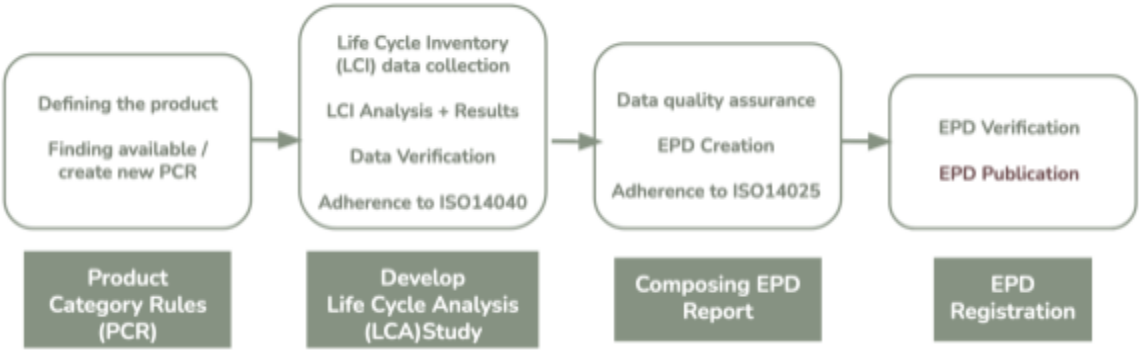

Figure 5: EPD Creation Process

2.3 The Role of Stakeholders

Implementing this project involves five key stakeholder categories (Figure 6): government, capital, corporate, knowledge, and community. The Lao Government, including departments such as Pollution Control, Planning and Finance, and the National Plastics Action Plan Secretariat, along with ministries such as the Industry & Commerce and Public Works & Transport, will establish policies and inter-ministerial coordination to integrate co-processing into decarbonization and waste strategies at the national level. Municipal bodies, such as the Luang Prabang Provincial Government and the Urban Development Administration Authority (UDDA), will facilitate local implementation in coordination with the national government, capital stakeholders, corporate stakeholders, as well as the local community in which the concrete plant resides.

National and municipal governments must collaborate through an inter-ministerial task force to support corporate adoption of co-processing, formally recognizing its dual benefits of energy recovery and mineral recycling in waste policies by codifying R15 under Annex IV of the Basel Convention into the national decarbonization and waste management strategy.

Capital stakeholders, including multilateral development banks, such as the Asian Development Bank (ADB) and the Cement Sustainability Initiative (GCCA-WBCSD), will provide resources and frameworks

for sustainable investment and technical knowledge. Corporate stakeholders, such as Laotian cement companies (e.g., Luang Prabang Conch or Souksomboon Group) and private waste management firms under UDDA's designation, will operationalize co-processing and manage the logistics of waste-to-energy systems.

Knowledge stakeholders, including organizations like the Global Cement and Concrete Association (GCCA), the Asian Development Bank Institute (ADBI), International Organization for Standardization (ISO) World Business Council for Sustainable Development (WBCSD), and Building Transparency, will ensure the oversight of EPDs and Life Cycle Assessment (LCA) systems, maintaining transparency and accuracy in environmental records. Finally, community stakeholders, including the informal sector (e.g., waste pickers and small-scale recyclers) and residents near cement facilities in regions like Luang Prabang and Khammouane, will be integrated into the formal economy through roles in co-processing preparation, contributing to inclusive economic opportunities while supporting sustainability goals.

Figure 6: Key Stakeholders

2.4 Relevance of solution

This proposal directly addresses issues outlined in "2.1 Solution Requirements and Objectives," meeting Laos' needs by formalizing and codifying co-processing into the national plan, optimizing resource use

by incorporating abundant, mismanaged waste into co-processing. Leveraging existing kilns, inherently suitable due to their high temperatures and long-residence times, minimizes costs, with estimated annual savings of $11.5M in cement production. The inter-ministerial task force and EPDs will provide policymakers with tools for coordination and monitoring, enabling Buy Clean initiatives and expanding markets for sustainable construction materials. A successful concrete EPD project could extend to other green products, promoting best practices, enhancing trade in sustainable cement, and amplifying its impact across Southeast Asia. Most importantly, this approach retains the benefits of concrete without compromising on its usage (Figure 7).[39]

Figure 7: Benefits of concrete for climate resilience

3. Implementation plan

3.1 Pilot

To pilot this solution, this project proposes the site of Luang Prabang, a city in North central Laos which has been a focus of Laotian development efforts in recent years. The city exemplifies many of the core issues Laos is facing, including: increasing demand for concrete, waste mismanagement, and air pollution.

[39] Global Cement and Concrete Association. GCCA Policy Document on Co-processing.

Following in line with the "battery of Southeast Asia" goal highlighted in section 1.2, Luang Prabang is the site of a new hydropower project expected to be commissioned in 2029.[40] It will be designed as a roller-compacted concrete gravity dam,[41] necessitating a steady source of concrete for construction efforts. In addition to this, Luang Prabang also faces increased concrete demand in the face of damage from recent bushfires. In particular, two resorts incurred damage from March 2023 fires,[42] hitting in the tourism sector even harder in the wake of COVID-19. Rebuilding efforts give additional context to support growing concrete needs in the city.

On the side of waste, Luang Prabang reached a waste generation rate of 25,000 tons in 2020, and with tourism numbers contributing to this waste generation the total waste amounts are expected to increase to around 42,000 tons by 2035.[43] Based on a 2020 survey conducted by Cities Development Initiative for Asia, it was found that the region's waste is 45-50% organic waste, 10-15% plastic, 10-15% paper and cardboard, 2-5% metals, 2-5% glass, and 5-10% other waste.[44] This makes Luang Prabang an ideal co-processing candidate, as the vast majority of their waste can be utilized in the process. Additionally, co-processing would serve as a value step in Luang Prabang's waste management.

Currently, waste collection in Luang Prabang is operated jointly by the Urban Service Office (USO) of Luang Prabang City and the private company Sai Namkharn Saat, with each party collecting waste from 40 villages. Households are expected to pay a fee of 20,000 kip/month, with that fee being 100,000-200,000 kip/month for hotels and restaurants. Once collected, the waste is transported directly to the landfill, where 40 registered waste pickers collect items such as plastic and glass bottles, metal, and paper.

Luang Prabang's landfill, the "Km 8 Landfill," poses significant social and environmental concerns that may benefit from the implementation of co-processing. As the only dumpsite in the city, the landfill

[40] "Luang Prabang Hydropower Project, Laos," Power Technology

[41] "Luang Prabang Hydropower Project, Laos," Power Technology

[42] "Two Resorts in Luang Prabang Report Damage Due to Forest Fires," Laotian Times

[43] "Supporting Lao PDR to Improve Solid and Plastic Waste Management Solid Waste Assessments," World Bank

[44] "Feasibility Study for Lao People's Democratic Republic: Urban Environment Improvement Investment Project (Luang Prabang)," Asian Development Bank

contributes to poor air quality in the area surrounding it, and the many residents who live in its direct vicinity suffer for it. There have also been instances of uncontrolled windblown litter, malodor spreading to nearby residents, and potentially infectious vermin who pose a threat to waste pickers, landfill workers, and local residents.[45] As assessed by the ADB: "the operations at the existing dumpsite do not meet the environmental standards expected of a managed landfill operation."[46]

The introduction of co-processing and EPDs may serve as a valuable tool in simultaneously easing the landfill burden, improving air quality, and establishing a greener construction industry to ensure lasting benefits. In collaboration with the USO, international organizations with a stake in the region, and local volunteer groups, this pilot would aim to: (1) set up more thorough waste segregation, (2) establish a waste treatment facility, (3) incorporate co-processing systems into the local cement plant, and (4) introduce EPDs for locally produced cement. This initiative would encourage a circular approach to waste, fostering an enabling environment in the region. It would also create socioeconomic opportunities for local stakeholders. Enhancing formalized waste segregation and treatment could better the livelihoods of registered and unregistered waste pickers and landfill workers by ensuring a safer environment.

Implementation would be eased by the fact that Luang Prabang already has a cement plant in place. Additionally, the groundwork for sustainable development has already been laid, with several initiatives in place which would exist symbiotically with this proposed pilot. This includes an ADB concessional loan and grant for the Urban Environment Improvement Investment Project (which prioritizes heritage sites, a clean and safe environment, and sustainable villages),[47] and the Plastic Smart Cities initiative (which aims to reduce landfill waste and increase the recovery of recyclable materials by implementing waste segregation at the source).[48] These initiatives, particularly Plastic Smart Cities, demonstrate not only an eagerness for a greener Luang Prabang, but a willingness to take concrete steps toward that

[45] "Feasibility Study for Lao People's Democratic Republic: Urban Environment Improvement Investment Project (Luang Prabang)," Asian Development Bank

[46] "Feasibility Study for Lao People's Democratic Republic: Urban Environment Improvement Investment Project (Luang Prabang)," Asian Development Bank

[47] Koumelis, "ADB to Support Urban Environmental Improvements in Luang Prabang, Lao PDR." Southeast Asia Development Solutions.

[48] Maureen, "Luang Prabang Officially Joins Plastic Smart Cities," Plastic Smart Cities,

goal.

3.2 Funding and costs

3.2.1 Co Processing business model and funding

According to the German development agency GIZ, one of the reasons why co-processing projects can fail is due to the lack of communication leading to misalignment of expectations and costs.[49] Often, organizers of the project expect concrete plants to pay for the waste, due to it reducing costs. However, concrete plants can also expect to be paid for using waste in the concrete production process since it increases the complexity of production. It is important for all stakeholders to understand the costs associated with each stage of the project. That is why a joint venture between the local government and the concrete plant owner supported by international organizations is proposed. This collaborative approach certifies that stakeholders involved in waste collection, processing, and concrete production work collaboratively and share the benefits. Another potential issue GIZ highlights is the necessity to guarantee long-term supply of waste. For concrete plants, investing in specialized equipment for co-processing is pointless if the project is the waste collector is unable to guarantee the long term supply of waste. That is why having the government, responsible for most of the waste collection in Laos, directly have a stakeholder in the project should satisfy any uncertainties regarding the long-term sustainability of the project.

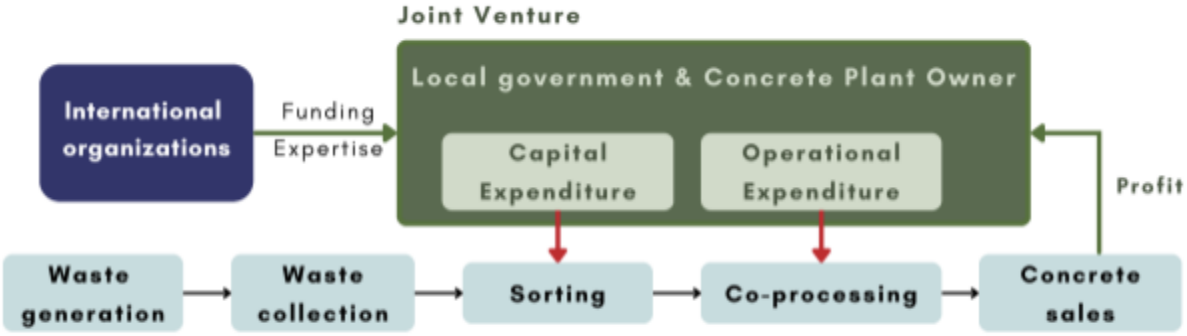

Figure 8: Proposed business model for the project

[49]"Guidelines on Pre- and Co-Processing of Waste in Cement Production." Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) .

Co-processing in Laos can be financed through a blended finance model, leveraging both private sector investments and support from international financing institutions. A similar approach was seen in Egypt, where the European Bank for Reconstruction and Development (EBRD) provided a long-term loan of up to EUR 50 million to Assiut Cement Company.[50] This funding enabled the use of alternative fuels such as biomass and refuse-derived fuel alongside traditional options like pet coke and coal, aiming to offset CO2 emissions. For Laos, international funds such as the Green Climate Fund (GCF) and organizations like the United Nations Industrial Development Organization (UNIDO) could provide grants or low-interest loans to the joint venture, along with technical expertise to support implementation. By incorporating private sector investment through equity contributions or debt financing, the joint venture between the local government and concrete plant owners can distribute costs across multiple stakeholders. This blended finance model guarantees financial viability for co-processing while reducing reliance on the Lao government's limited budget.

3.2.2 EPD funding

Funding for the EPD aspect of the project can leverage several cost-effective and accessible resources. Non-governmental organizations like Building Transparency offer free tools such as the EC3 platform, along with open-access training and educational materials to facilitate EPD creation.[51] Capacity-building initiatives can also be supported by multilateral organizations like the Asian Development Bank (ADB), which actively promotes sustainable material use and procurement.[52] With ADB's history of providing loans and grants to Laos, including the recent $35 million concessional loan and $10 million grant for sustainable urban development in Luang Prabang, access to training through programs like those offered by the Procurement, Portfolio, and Financial Management Department (PPFD) should be feasible.[53] These resources will provide the resources necessary for financing and integrating EPDs in Laos.

3.2.3 Projected costs

[50] "Cemex Egypt." European Bank for Reconstruction and Development. 2015.

[51] "EC3 - Building Transparency." Building Transparency.

[52] "ADB-ADBI Workshop on Sustainable Public Procurement Helps Build a Greener Future in Asia and the Pacific." Asian Development Bank.

[53] "Operational Procurement." Asian Development Bank.

The projected costs for the Luang Prabang co-processing project were derived from the International Finance Corporation (IFC) of the World Bank Group.[54] They estimated the capital expenditures (CAPEX) and operational expenditures (OPEX) figures for a sorting line using municipal waste with a capacity of 250,000 tons per year, to be around €1–€2 million, while OPEX ranges from €5–€15 per ton. These larger-scale figures were adjusted proportionally to reflect the smaller scale of operations needed for the project. The preparation phase of the project will likely cost around $10,000 USD to establish the project plan and begin to build the team. The pilot will involve a capital expenditure (CAPEX) of around $500,000 and operating expenses (OPEX) of $10–$15 per ton annually. For the EPD arm, considering the cost savings resulting from utilizing the tools provided by Building Transparency together with results from past case studies, we anticipate that it will cost around $13,000 per EPD.[55] If the pilot project goes according to plan, the expansion will see the same costs for EPD expansion, while co-processing expansion costs will depend on the business model and waste type.

3.4 Project timeline

The expected projected timeline for the project is depicted in *Figure 8*. The implementation of co-processing and EPDs will require coordination with a wide range of stakeholders to succeed. Therefore, careful planning before its implementation is necessary to engage the private sector and gauge interest. It is expected to take approximately a year and a half to build the necessary government capacity, acquire funding, coordinate with private sector stakeholders, and prepare for the project and the pilot. Once planning is complete, retrofitting the concrete plant in Luang Prabang should be relatively simple and can be completed by the second half of the third year. By evaluating the results and effectiveness of the pilot project, preparations for the expansion of co-processing in other concrete plants throughout Laos can begin. As more concrete plants implement co-processing, EPDs for concrete are simultaneously introduced to promote green concrete domestically and across the region. While there is no 'end' to the project as new concrete plants may be built in the future, towards the end of the fourth year, the environment for co-processing and EPDs is expected to be established and

[54] "Increasing the Use of Alternative Fuels at Cement Plants: International Best Practice." International Finance Corporation.

[55] Tasaki, Shobatake, Nakajima, and Dalhammar. "International Survey of the Costs of Assessment for Environmental Product Declarations".

expanding self-sufficiently. By this point, while refinement of implementation may be necessary, this can be conducted with the established monitoring team within the government.

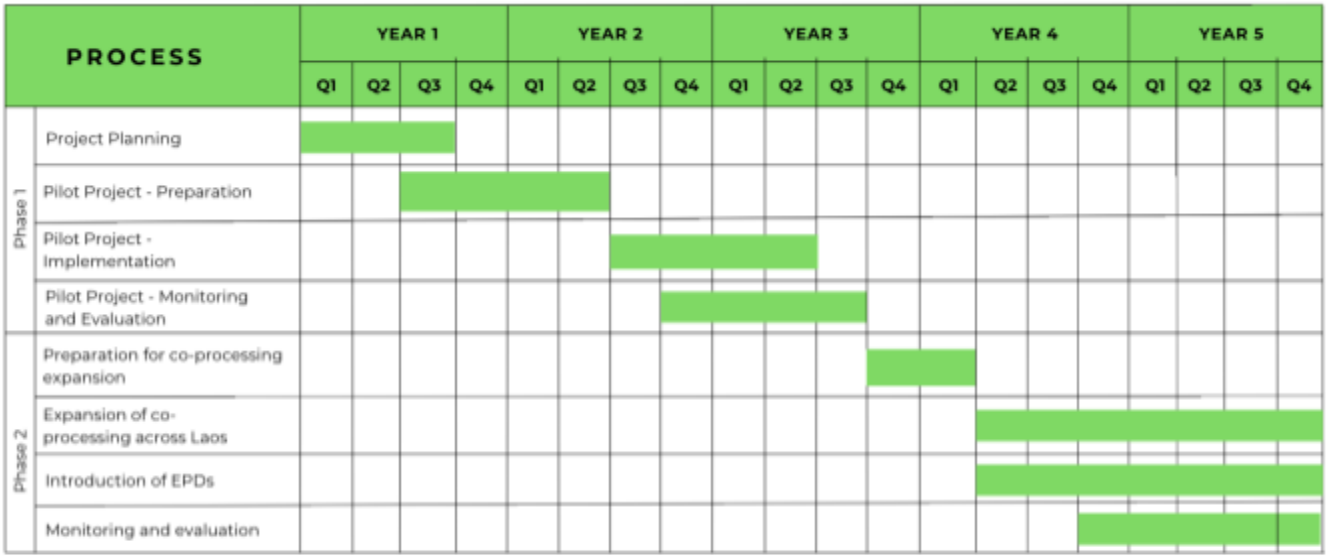

Figure 9: Project timeline GANTT chart

3.5 Implementation and results monitoring

A robust monitoring and evaluation framework will be implemented to measure the success of the project but also to ensure that any negative externalities can be detected and dealt with as soon as possible. Both quantitative and qualitative indicators will be used throughout the project, as shown in Figure 9. The indicators highlighted red in the diagram aim to identify and address any negative externalities or issues that may arise.

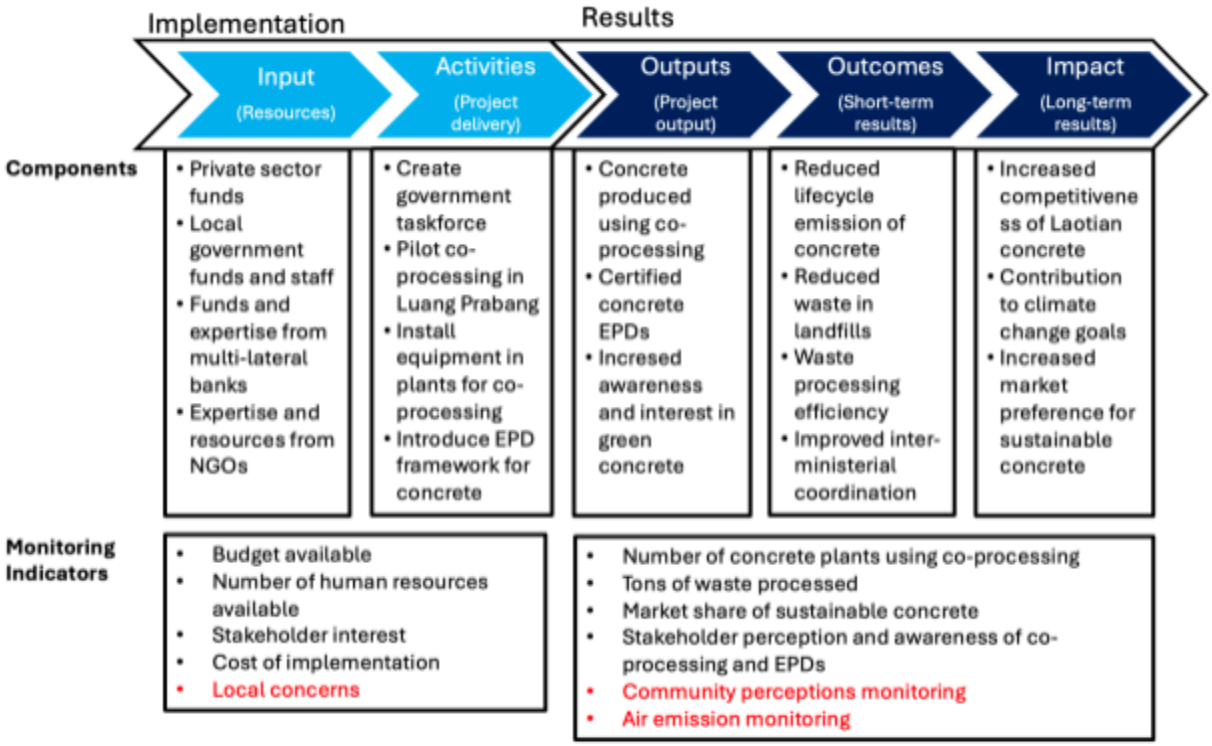

Figure 10: Results chain of the project

The pilot project should mitigate any unexpected risks or costs, and since this project can be expanded by region and/or concrete plant, as long as robust planning and results monitoring is conducted, implementation can be adjusted accordingly.

4. Conclusion

Laos faces significant environmental challenges from its cement industry, exacerbated by waste mismanagement and the lack of standardized monitoring tools within its policy framework. Our project addresses these issues by institutionalizing co-processing and Environmental Product Declarations (EPDs), which will reduce greenhouse gas emissions, optimize resource utilization, and encourage sustainable construction practices, while establishing a scalable framework for regional implementation. This project aims to make the concrete industry in Laos more sustainable by reducing emissions, improving waste processing efficiency, and reducing landfill waste. It also seeks to improve the competitiveness of Laotian concrete in global markets while supporting climate change efforts. Conducting a pilot project and upholding a robust results framework with support from industry experts

should ensure that the risks are mitigated and that the benefits are maximized, increasing the likelihood of the success of the project.

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