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# Calcined clay

## Accelerating and diversifying opportunities for clean cement

July 2025

# Context and objectives of this document

## Context

- This document is part of Mission Possible Partnership's broader **effort to accelerate low-carbon construction materials.** Specifically, this initiative explored opportunities to accelerate the production and consumption of calcined clay in Türkiye, the UAE and Saudi Arabia as a critical material to achieve fast emission reduction in the cement and concrete sector
- This document outlines key insights from 60+ bilateral conversations (held from October 2024 to May 2025) and a meeting on May 9th 2025 in Lausanne, hosted by the LC3 Project, MPP and Systemiq - with philanthropic support from HSBC
- The initiative aims to pinpoint critical actions and engage pioneering stakeholders to turn momentum into real deployment of calcined clay-based cement, whether through collective or independent action

## Objectives of this document

1. Describe **the opportunity and objectives** behind calcined clay[1] as a low-carbon cement solution
2. Provide insights on **how to accelerate the production of and demand for** calcined clay
3. Share a focused **Call to Action** to drive this further, through 5 clear initiatives


1 Limestone Calcined Clay Cement (LC3) refers to a blend of limestone, calcined clay, and clinker, which together undergo synergistic chemical reactions that enhance cement performance while enabling significant clinker reduction.

# 1

## Calcined clay
## the opportunity

SUMMARY

# How calcined clay is **critical** for cement decarbonisation and other side benefits

- Concrete is the second most consumed material on the planet after water, and its widespread use will persist well into the future.
- Global cement manufacturing is responsible for about 8% of the world's total $CO_2$ emissions. Decarbonisation of the sector is critical. Solutions to decarbonise this sector need to be able to reach this enormous scale to be relevant.
- Calcined clay-based cement is low-carbon and low-cost and can be applied in existing supply chains:

> Replacing clinker with calcined clay and limestone in cement reduces $CO_2$ emissions by over 40% and energy costs by over 33% compared to Ordinary Portland Cement (OPC).
>
> Infrastructure projects across the world — including in Colombia, Switzerland, and Brazil — already use calcined clay cement, demonstrating proven performance and scalability. Calcined clay is also already embedded in international cement standards.
>
> Compared to other Supplementary Cementitious Materials (SCMs) such as Ground granulated blast-furnace slag (GGBS) and fly ash, calcined clay is more abundant and less subject to declining availability or rising costs.
>
> Calcined clay-based cement mixtures offer similar strength and durability than alternatives, and it is more suitable for harsh environments.




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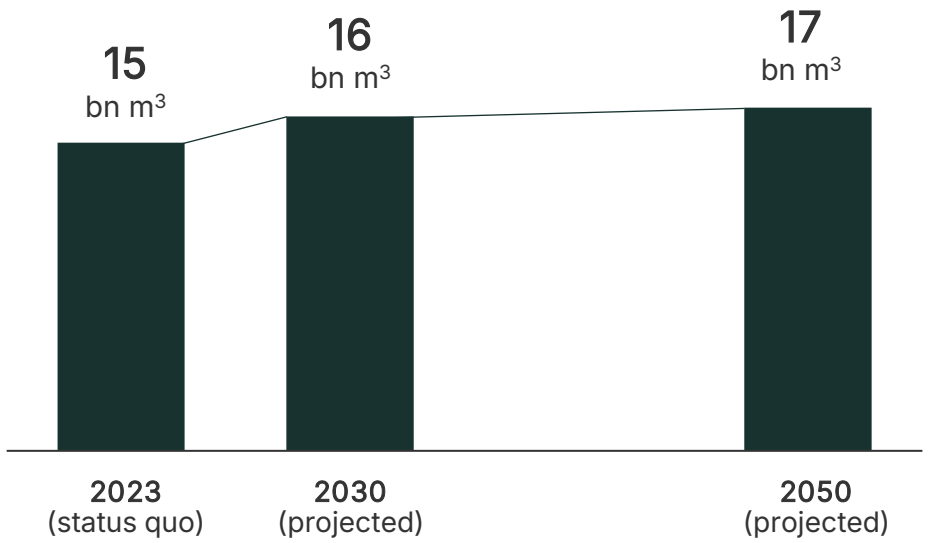
Calcined clay-based cement is low-carbon and low-cost and can be applied in existing supply chains

## ...and we'll continue to use it on a large scale in the future

### Current and projected concrete use

bn m3 concrete




**Additional note**: Cementitious materials make up >50% of everything we produce.
**Sources**: Statista (2024); Projections based on Mission Possible Partnership (2023)

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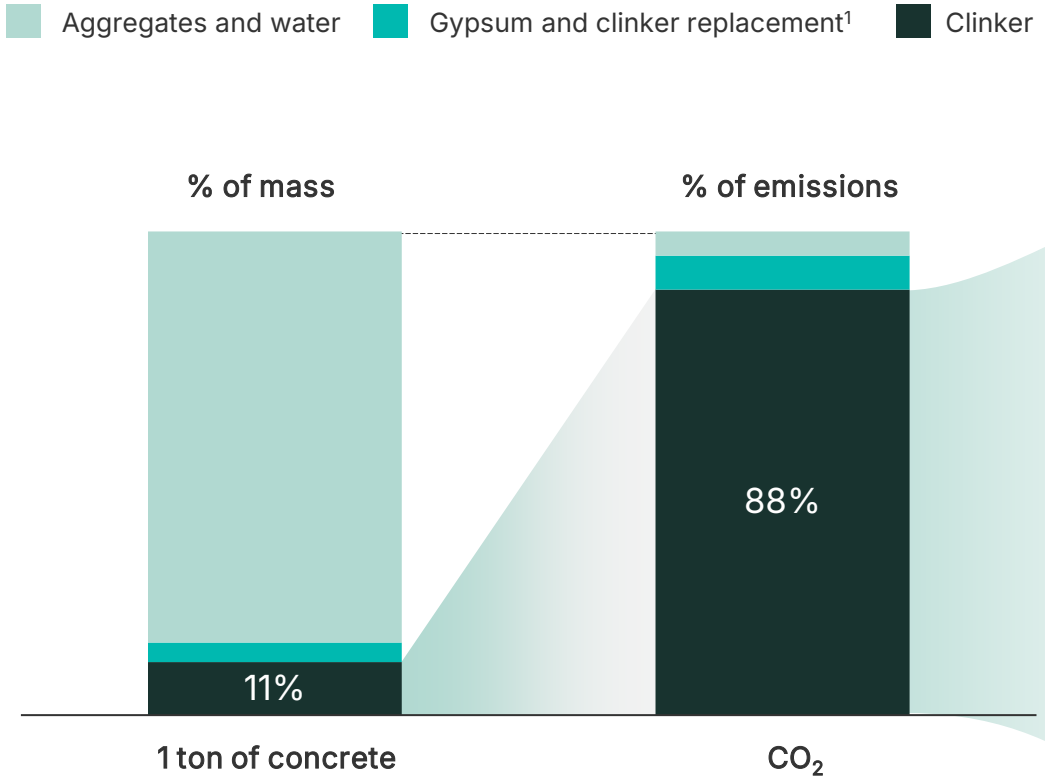
# Clinker replacement materials offer a fast and effective route to lowering emissions in concrete production

## Clinker is responsible for majority of the emissions in concrete

Breakdown of mass and CO2 emissions for 1 tonne of concrete, %




## From a carbon budget (i.e. reduction & speed) perspective, replacing clinker is the key priority

High Medium Low

| | TRL | TRL[3] | Implem-entation speed | Emission reduction |
|---|---|---|---|---|
| | Energy efficiency improvements, electrification and switching to alternative fuels only get us thus far... | High | High | Low |
| | **Replacing as much clinker with clinker-replacement materials[1] reduces the clinker factor) and provides a cost-effective solutions today** Focus of this document | High | High | Medium |
| | The remaining emissions will need to be captured through CCU/S[2], adding permanent system costs and complexity | Low | Low | High |

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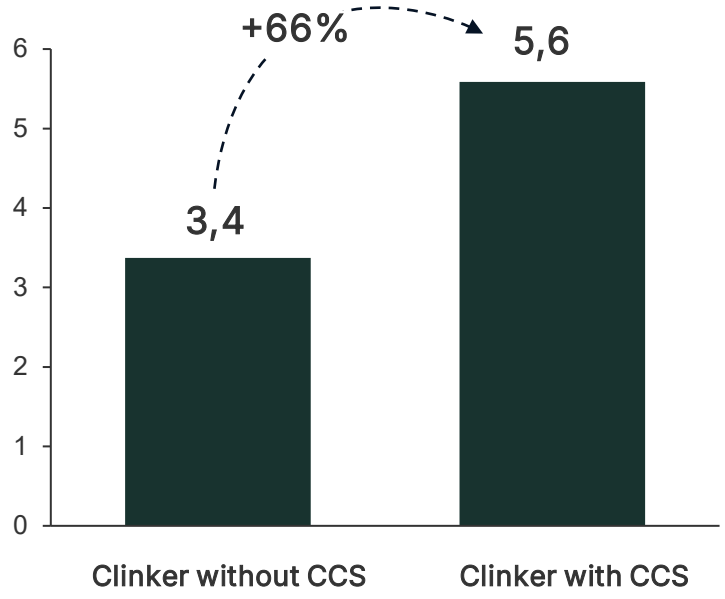
**Notes: 1.** Also known as Supplementary Cementitious Materials (SCMs); **2.** Carbon Capture and Utilisation and/or Storage; **3.** Technology Readiness Level (TRL)
**Sources**: Mission Possible Partnership (2023); Expert interviews

# Because carbon capture increases energy use and production costs, it is most effective when deployed alongside other cost-effective decarbonisation levers

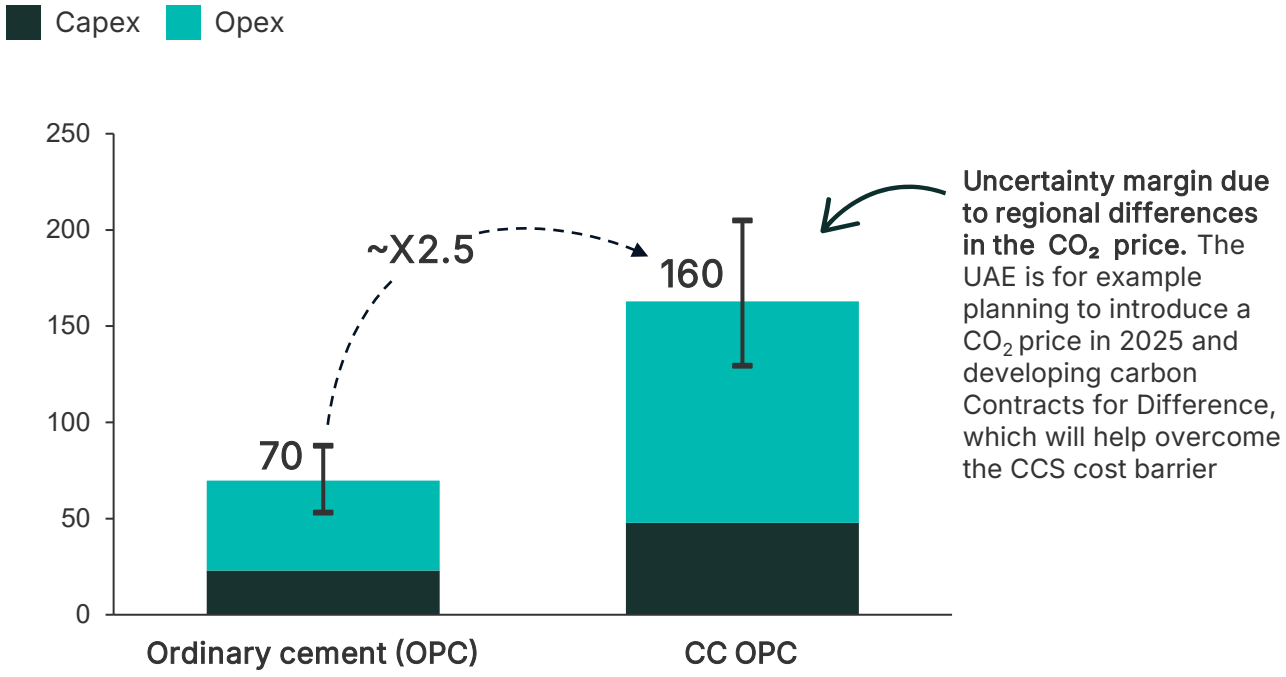
## Clinker production energy consumption

GJ/ t cement




## Estimated cost of cement production[1]

$/t cement



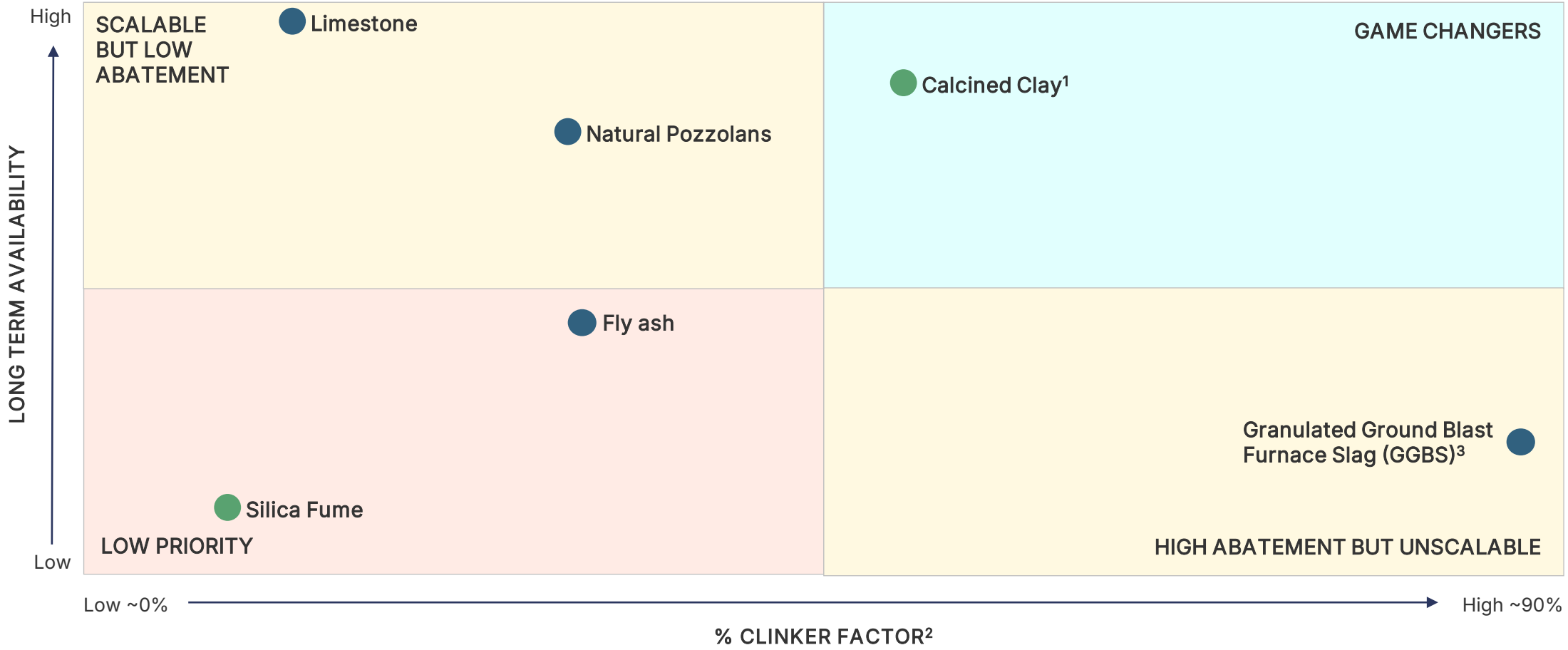

**Uncertainty margin due to regional differences in the $CO_2$ price.** The UAE is for example planning to introduce a $CO_2$ price in 2025 and developing carbon Contracts for Difference, which will help overcome the CCS cost barrier

**Notes: 1.** Modelled assumptions include plant size: 1 Mt CEM I pa, power price: $96-$66/MWh; coal price: $4.5/GJ; limestone and gypsum price: $10/t, clay price: $4/t. $CO_2$ transport and storage costs for Gulf countries: $25-40/t $CO_2$; WACC: 8%; CAPEX dry coal kiln: $192/t Clk pa; CAPEX dry coal kiln + CCS: $322/t Clk pa (average of post-combustion and oxyfuel); CAPEX rotary kiln for clay calciner: $10M for 300 kt pa. **2.** See back-up for calculations and assumptions. **3.** Stakeholder insights. All costs are based on 2024 USD. Detailed assumptions in model are based on most recent available data.
**Sources:** AISU (2023); UAE MoCCE (2023); IMF (2025); Mission Possible Partnership (2023); K. Scrivener, A. Dekeukelaere et al. (2019); Kapsarc (2023); Systemiq internal analysis, Turner & Townsend (2024). Stakeholder conversations

# Only a few cement replacement materials can lead to high abatement and are scalable in the long-term

## Mapping of commercially available clinker replacements (or so called supplementary cementitious materials)

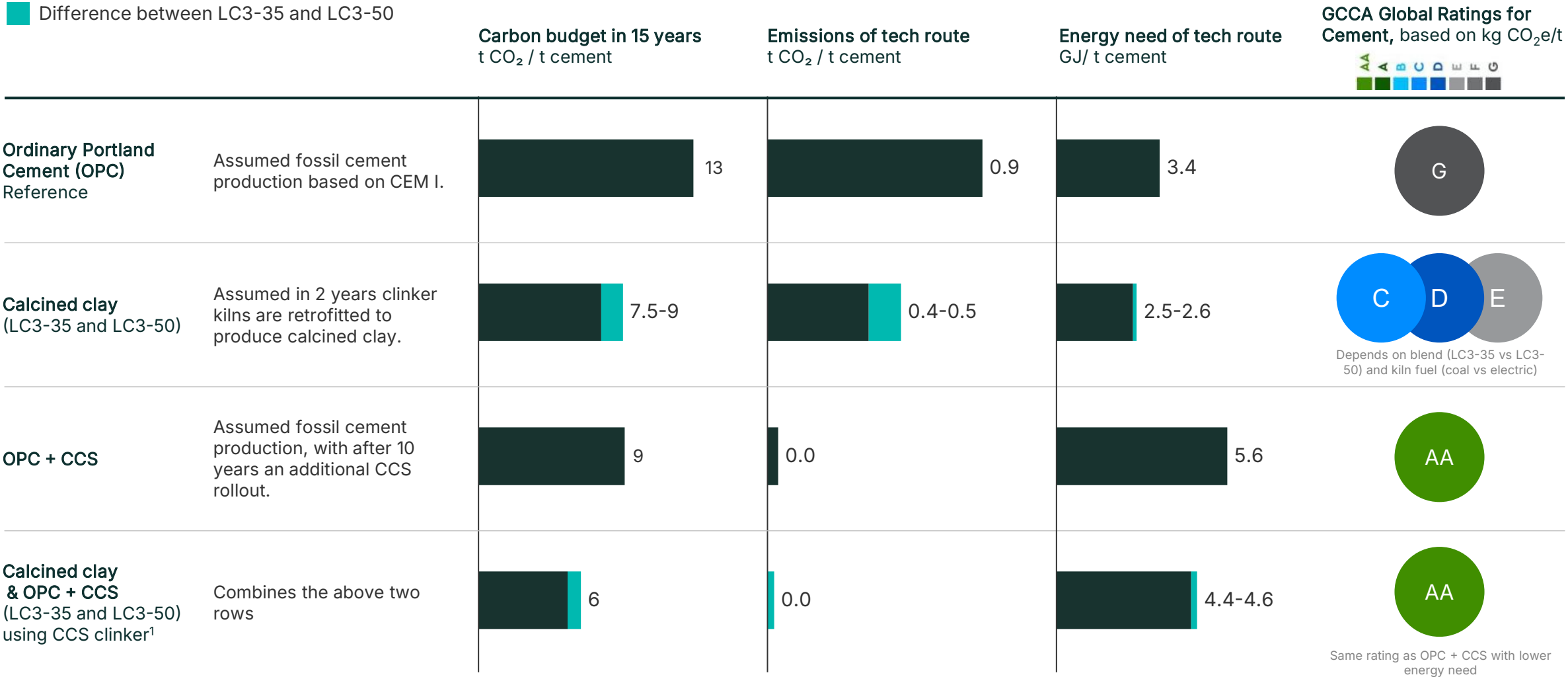
Widely used clinker replacements  Emerging clinker replacements




**Notes:** The position in the chart is indicative and varies based on application and quality of the available material. **1.** Calcined clay in LC3 mixture is a blend with clinker & limestone and works with different clinker factors (e.g., 50% or 35%). **2.** Clinker factor in cement blend with plotted dominant clinker replacement. **3.** Based on IEA's NZE scenario and further studies highlighting low long-term availability of GGBS.
**Sources:** Juengar et. al (2019). Supplementary cementitious materials: New sources, characterization, and performance insights; Pekmezci, S. Akyüz (2004). Optimum usage of a natural pozzolan for the maximum compressive strength of concrete; Silica Fume Association; GCCA. Limestone Filler.; Arnold, W., Astel, P., Forman, T., & Drewniok, M. (2023). The efficient use of GGBS in reducing global emissions. Institution of Structural Engineers, United Kingdom.

# Calcined clay-based cement reduces emissions and energy need and is synergetic with carbon capture

## Performance Comparison of OPC and LC3 Across Mixtures, With and Without Carbon Capture on OPC




**Notes:** For Carbon Capture (CC), we assume 5% of residual emissions. We assume construction time of calcined clay retrofit of two years, for CC+S installation we assume 10 years. GCCA ratings are based on numerical definitions highlighted on their website. For OPC we assume 95% clinker factor, for LC3-50 a 50% clinker factor, for LC3-35 a 35% clinker factor.

**Sources:** Systemiq internal analysis, Mission Possible Partnership (2023); K. Scrivener, A. Dekeukelaere et al. (2019); Climatiq (2024); GCCA (2025), GCCA Global Ratings for Cement

Recommend to also apply rating at concrete level, as higher-strength mixes place greater demands on the cementitious materials involved.

# Calcined clay-based cement is **low-carbon** and **low-cost** and can be applied in existing supply chains

## Cost
More than 33% reduction in energy costs vs. Portland cement

## Emissions
More than 40% reduction in emissions vs. Portland cement

## Commercial
Part of cement standards and fits within established value chain

## Availability
Abundantly available, invigorates local industry and scalable to the size of limestone

## Performance
Similar strength and durability than alternatives

**Notes:** Modelling analysis based on LC3 mixture. Calcined clay decreases dependence on Granulated Ground Blast Furnace Slag (GGBS). Calcined clay is included in international cement standards for use in constructions (CEM IV).
**Sources:** LeadIT (2024), Green Cement Technology Tracker

# **6 Mtpa** clay calciner installed capacity and many existing structures worldwide:

**LC3 blocks at the Swiss Embassy in New Delhi** 2015

**HS2 in UK** 2024

**Viaduct in Columbia** 2024

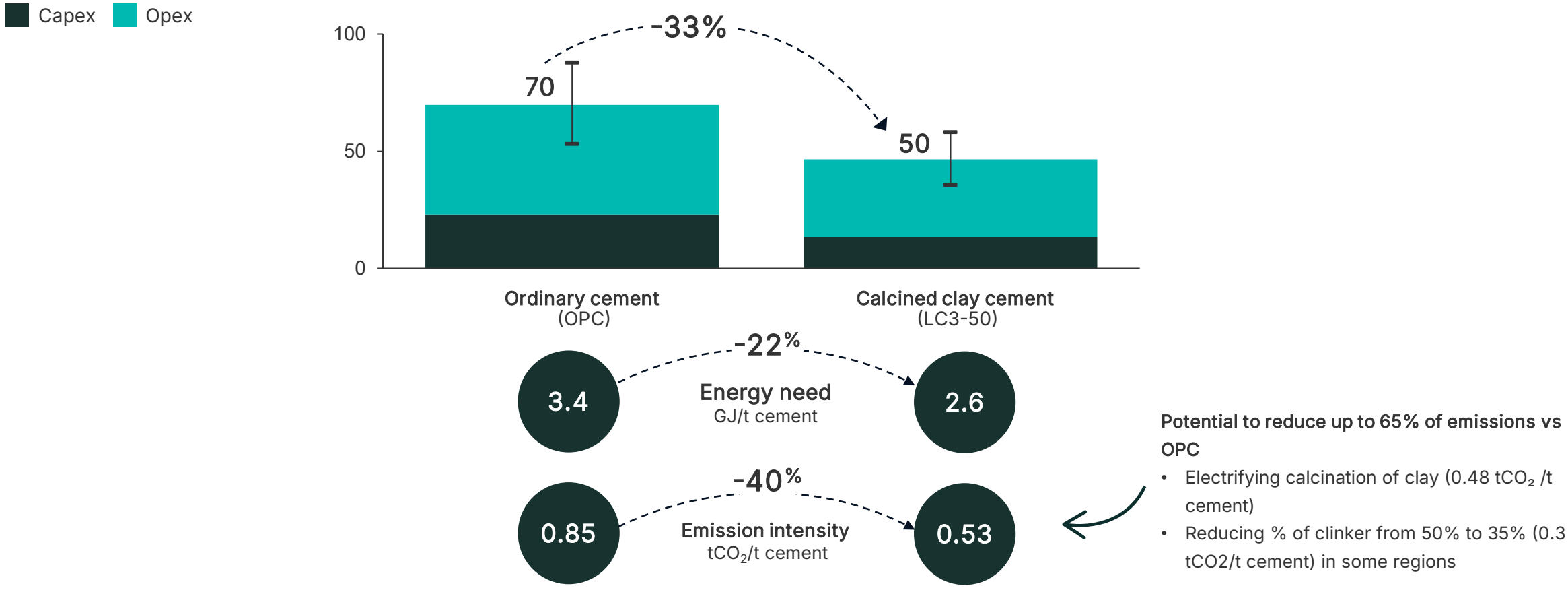
**85-meter Tilia Tower in Switzerland** 2026

COST | EMISSIONS

# Calcined clay is a **cost-effective solution for reducing emissions** in the MENAT region and one that is available today

## Estimated cost of cement

$/t cement




**Potential to reduce up to 65% of emissions vs OPC**

- Electrifying calcination of clay (0.48 $tCO_2$ /t cement)
- Reducing % of clinker from 50% to 35% (0.3 tCO2/t cement) in some regions

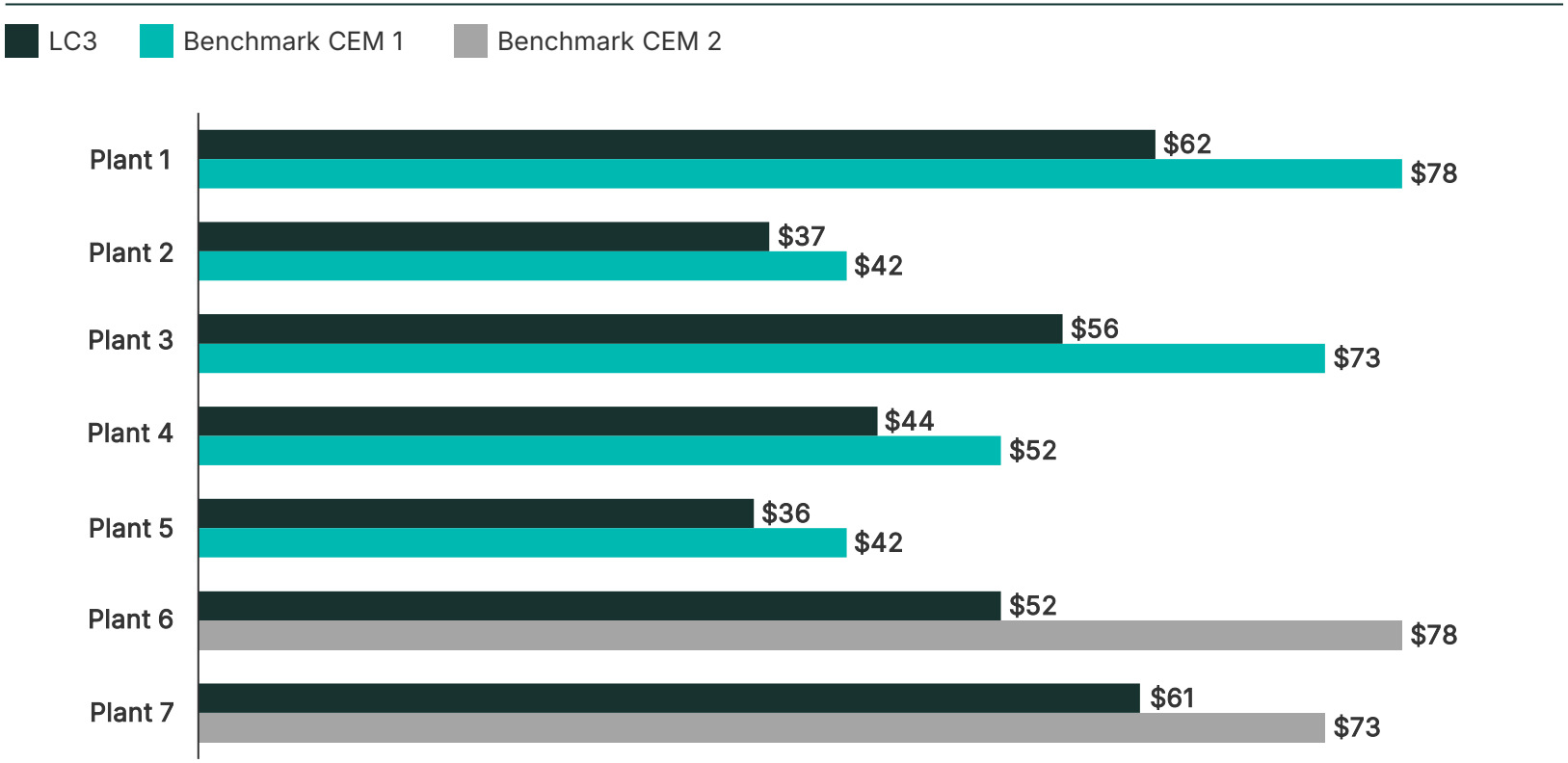
**Notes:** Fossil cement based on CEM I, calcined clay cement on LC3. Modelling assumptions include plant size: 1 Mt cement production pa; power prices: $66-96/MWh (2024-2050); coal price: $4.5/GJ; clay price: $4/t; WACC: 8%; CAPEX dry coal kiln: $192/t Clk pa, CAPEX rotary kiln for clay calciner: $10M for 300 kt clay pa. Emission intensity based on EU reference values for regional cement production.
**Sources:** Systemiq internal analysis, Mission Possible Partnership (2023); K. Scrivener, A. Dekeukelaere et al. (2019); Climatiq (2024).

COST | EMISSIONS

# Investments in calcined clay can deliver substantial operational savings

## Comparison of operating expenses at LC3 plants vs. benchmark cement plants

Costs in US$/tonne




## Key takeaways

**Strong returns in the right markets:**

Limestone and calcined clay-based cement can deliver high IRRs and payback, especially in regions with low clay costs, high clinker import prices and supportive policies (e.g., US, UK, EU).

**Context matters:**

Longer payback (up to 10 years) can result from higher retrofit costs, but remains viable where integrated plants and local clay access reduce overall costs.

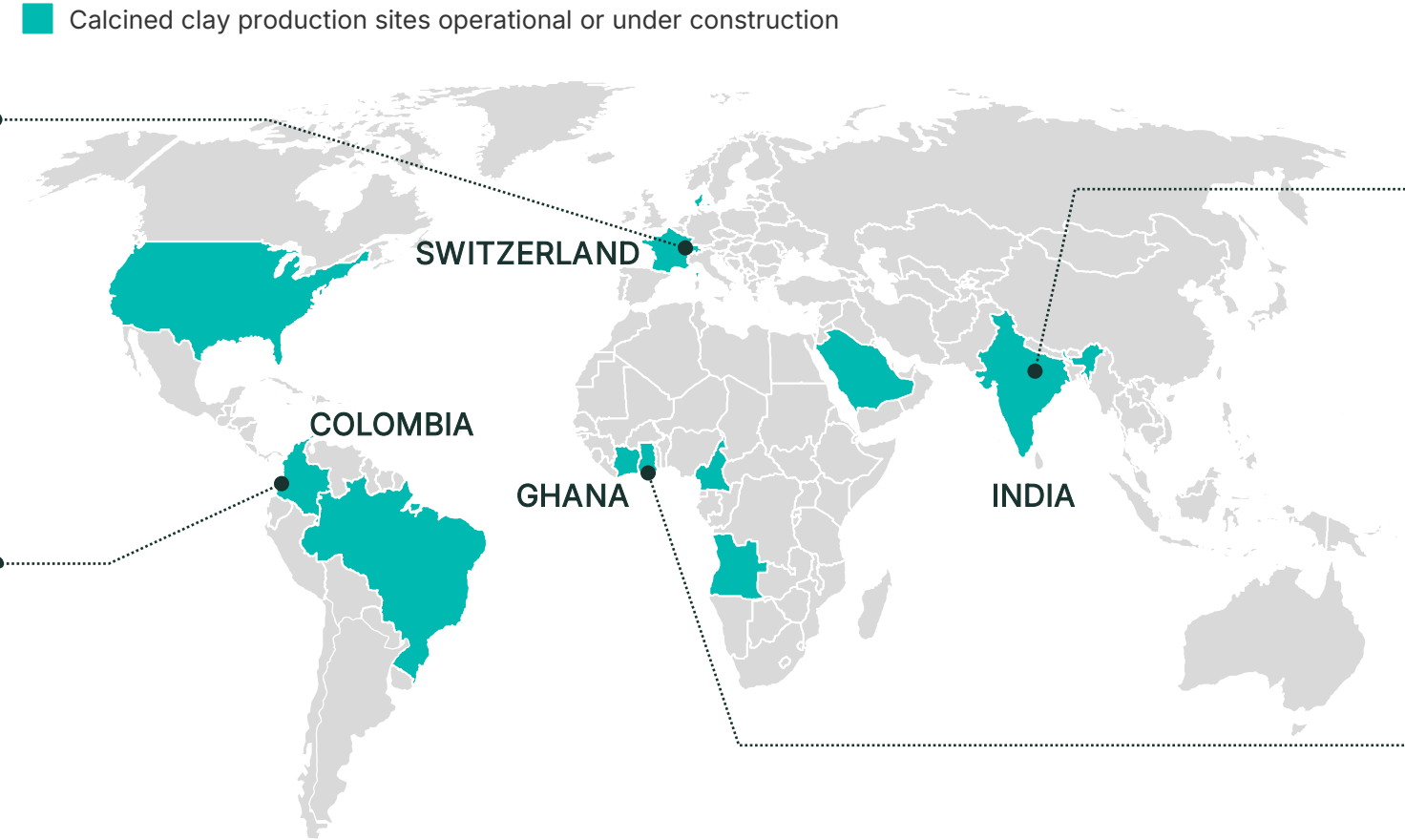
**Notes:** This overview provides 7 case studies in different geographies. Insights have been taken directly from Exhibit 10 of the RMI study.
**Sources**: RMI (2024), The Business Case for LC3

COMMERCIAL

# Infrastructure projects across the globe are using calcined clay, and it is **already embedded** in international standards

An 85-meter Tilia Tower near Lausanne, Switzerland (2026)

A viaduct above the Cauca River in Colombia is being constructed using calcined clay cement produced by Argos Cementos (2024)




Calcined clay cement was used in the construction of affordable housing in India (2022-2024)

Supacem Cement commissioned a US$100m facility in the port city of Tema, Ghana. This facility is described as the world's largest limestone calcined clay cement (LC3) plant.

Calcined clay is included in international cement standards for use in constructions (CEM II and CEM IV[1]), yet some local building standards do not explicitly allow calcined clay which can be a blocker for uptake of this material

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**Notes**: **1.** Calcined clay is recognised under CEM IV in the European Standard, an internationally accepted classification system for common cements.
**Sources**: Cemnet (2025); Climateworks (2024); NBM&CW (2024); LeadIT (2024); Tilia Tower (2025)

AVAILABILITY

# As other options become scarcer and pricier, calcined clay emerges as the **best available** clinker replacement

Decreasing / increasing trend  Range

| Type of clinker replacement | Global availability to replace clinker, mt/yr | Trends in source industry affecting future supply | Costs[2], $/t |
|---|---|---|---|
| Calcined clay | 6000+[5] | Kaolinite, the feedstock for calcined clay, is not dependent on another industrial process for its availability.[4] | 5-20 |
| Ground granulated Blast-Furnace Slag (GGBS)[3] | 600[6] | Availability of GGBS is decreasing due to iron & steel sector shifting to new technologies, Gt/yr capacity pig iron (projected): 2024: 2; 2040[1]: 0.8; -50% | 40-55 |
| Fly ash | 800[6] | Availability Fly Ash decreasing due to power sector shifting to renewable power generation, Gt/yr coal consumption power sector (projection): 2024: 8; 2040[1]: 2; -75% | 15-30 |

## COMPARISON OF CALCINED CLAY ON OTHER DIMENSIONS

### Strong
Achieves similar compressive strength through the synergistic reactions of calcined clay with limestone and clinker

### Resistant
Improved resistance to corrosion, chloride ingress, and alkali-silica reactions, making it well suited for use in marine or de-icing salt environments

### Production capacity
Existing capacity is low, but is growing exponentially from 3.8 in 2020 to 14.6 Mt/year in 2025. The product is proving viable across multiple applications.

### Abatement
Higher clinker replacement compared to Fly Ash, but lower compared to GGBS

**Notes: 1.** 2040 availability is based on IEA's NZE scenario. **2.** Please note, cost estimates highlighted here are general estimates. Specific costs are highly regional. **3.** Please note, in Germany, slag used in cement or concrete may be assigned a portion of the $CO_2$ emissions from the steelmaking process, due to policy/ accounting rules. **4.** Significant available volumes already exist — for example in tailings and dredged sediments. To unlock higher volumes, the development of new kaolinite quarries may be required. **5.** 2025 production capacity is 14.6 Mt/yr up from 10.3 in 2024 **6.** Use is estimated at 500 Mt/yr for GGBS and 300 Mt/yr for Fly Ash
**Sources**: Chemanalyst pricing data GGBFS (Q3 2024); Chemanalyst pricing data Fly Ash (Q3 2024); GCCA (2024); Global Blast Furnace Tracker (2024); IEA (2024); Scrivener (2019); UNEP (2016)

AVAILABILITY

# Beyond local demand: calcined clay can also be exported in various forms, depending on import market setup

**Local supply chain**

Clay

Calcined clay

Cement

Concrete

1. Export of **clay**

2. Export of **calcined clay**

3. Export of calcined clay-based **cement**

**External supply chain**

Calcined clay

Cement

Concrete



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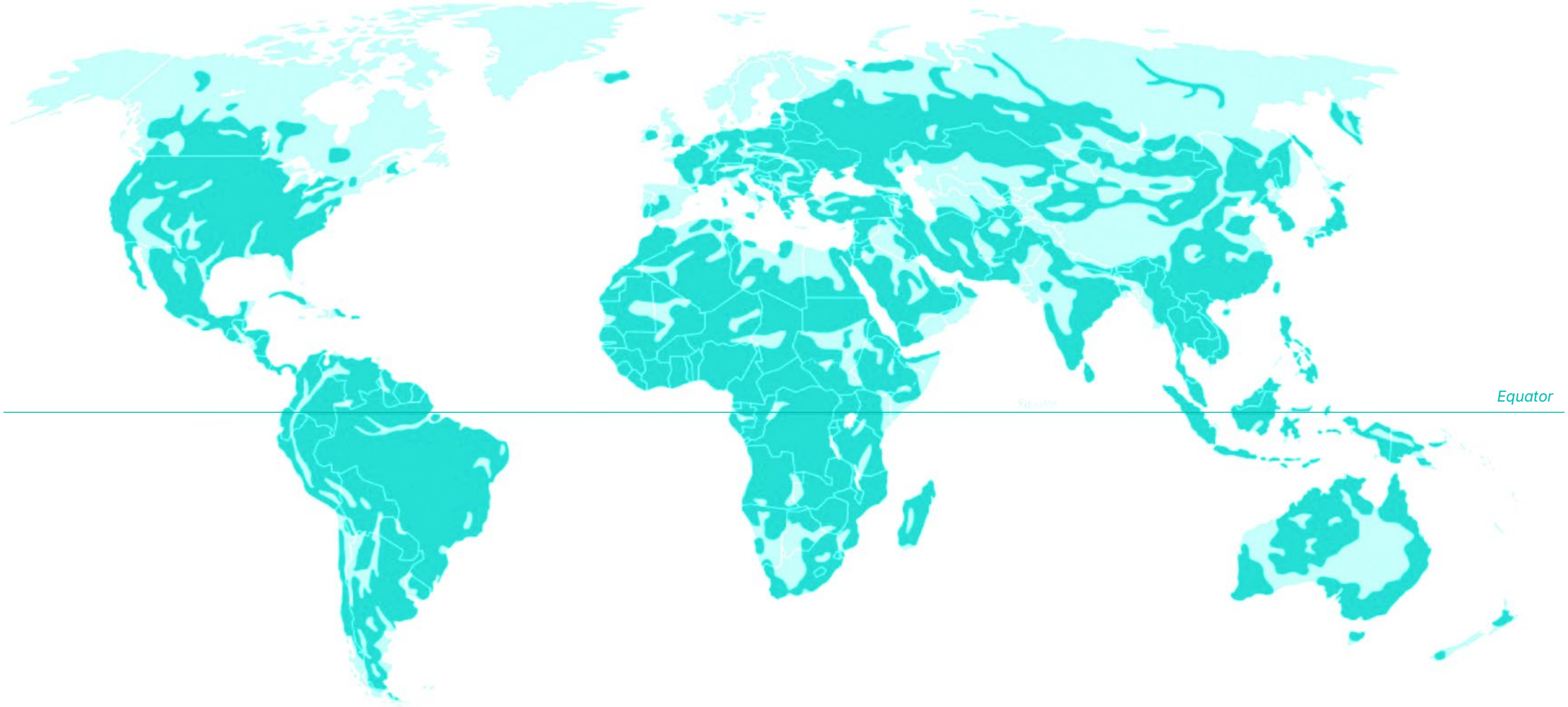
AVAILABILITY

# Kaolinitic clays are widely available

Kaolinitic clays




**Notes:** Global overview. Specific regional studies are also available in some locations.
**Sources:** LC3 project illustration. Based on ITA and Wagai Scientific data 2017


16

PERFORMANCE

# Use of calcined clay mixtures achieves **performance parity** with OPC and traditional blends, allowing for similar application and operational processes

**Performance vs OPC** Worse Similar Better

| Cement mix | Clinker substitution (%) | Compressive strength (Mega Pascal-MPa)[4] | | | | Workability | Durability |
|---|---|---|---|---|---|---|---|
| | | 1 day | 4 days | 28 days | 90 days | | |
| LC 3 (OPC + limestone + Calcined Clay) | 50% with potential for more[1] | 10 | 31 | 46 | 50 | Moderate increase in water consumption, comparable workability to OPC | High durability, suitable for harsh weather and marine environments (through high chloride resistance) |
| OPC + GGBS | 30-50% with potential for more[2] | 7.5 | 25 | 49 | 54 | Increased workability in comparison to OPC | High durability, suitable for harsh weather and marine environments (through high chloride resistance) |
| OPC + Fly ash | 15-30%[3] | 12 | 25 | 40 | 54 | Increased workability in comparison to OPC | High durability, suitable for harsh weather and marine environments |
| OPC (Original Portland Cement) | 0-10% | 21 | 34 | 44 | 45 | Standard workability | Standard chloride resistance and water absorption |

Mixtures performing at similar compressive strength benchmarks (30–50 MPa) enable flexible engineering of solutions, supporting diverse project specifications and performance criteria. Lower 1 and 4-day strength is expected and normal in calcined clay cements, but it is not a drawback for most structural applications



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**Notes:** 1. Compressive strength for mix using 30% calcined clay, 15% limestone, 5% gypsum and 50% clinker displayed here. **2.** Compressive strength for mix using 30% GGBS displayed here. **3** Compressive strength for mix using 30% fly ash displayed here. 4. All values deducted from Figure 3 of this publication. All values are subject to rounding.

**Sources**: LC3; K. Scrivener (2020) ; J. Liu et al (2023); Arup Australia (2024); L. Ferrari et al. (2023); B. Kanagaraj et al. (2024); V. Shah et al. (2020); Y. Dhandapani et al. (2018)

# 2

## Calcined clay
## accelerate scaling up

SUMMARY

# Challenges and interventions to scale calcined clay

Accelerating ‘tipping points’ for climate technologies fast-tracks economic impact and helps reduce climate change. Such tipping points are met when solutions are (1) Attractive, (2) Affordable and (3) Accessible.

Upfront investment requirements, perceptions in the market, and the absence of standards are barriers to reaching a ‘tipping point’ to scale calcined clay.

Based on conversations with industry stakeholders, 5 different initiatives emerged that aim to stimulate supply and demand for limestone and calcined clay-based cement:

**Improving perceptions** – Launching an awareness campaign on its readiness and use

**Enabling production** – Expressing intent to work with calcined clay through a demand signal, incentivising local demand

**Policy influence** – Developing short-term policy asks

**Deploying capital** – Validating the business case

**Showcasing potential** – Delivering a regional lighthouse (demonstration) project, supporting local developers to utilize the material

Accelerating ‘tipping points’ for climate technologies fast-tracks economic impact and helps reduce climate change.



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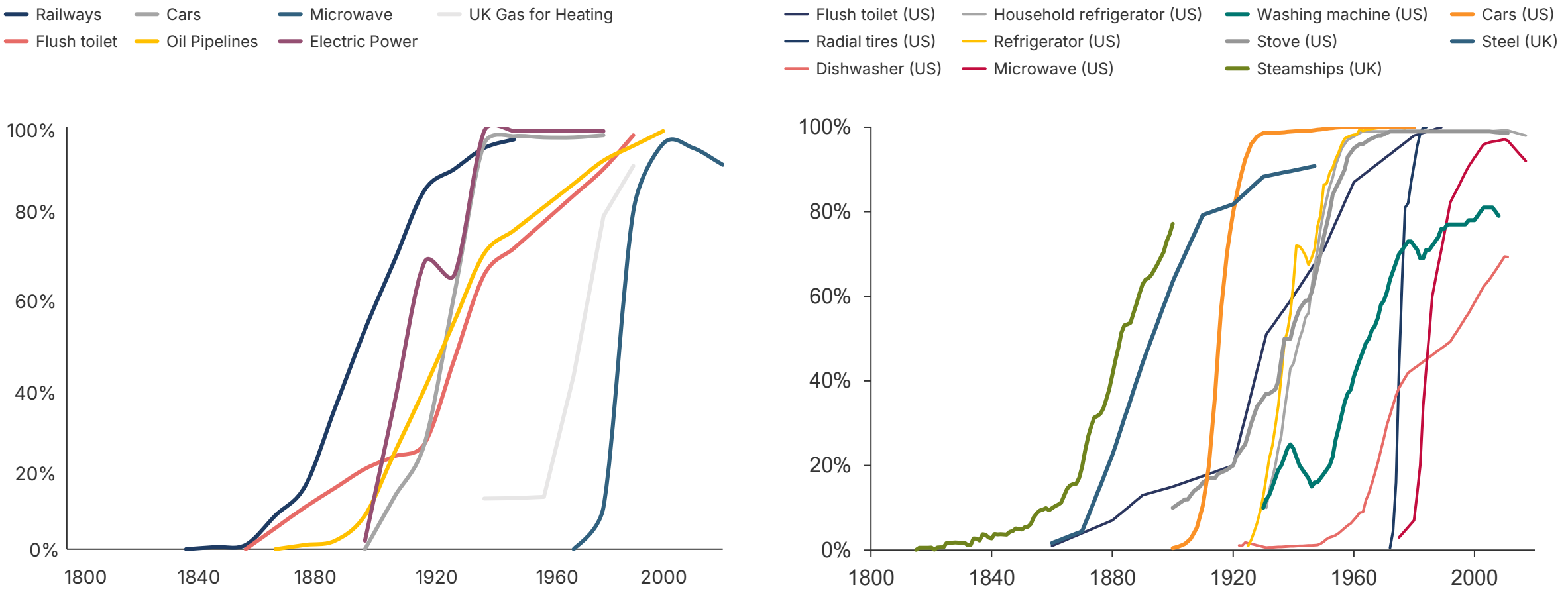
# How can calcined clay be scaled? It is possible - rapid transitions have happened before

## Historic adoption curves of new technologies over time

%



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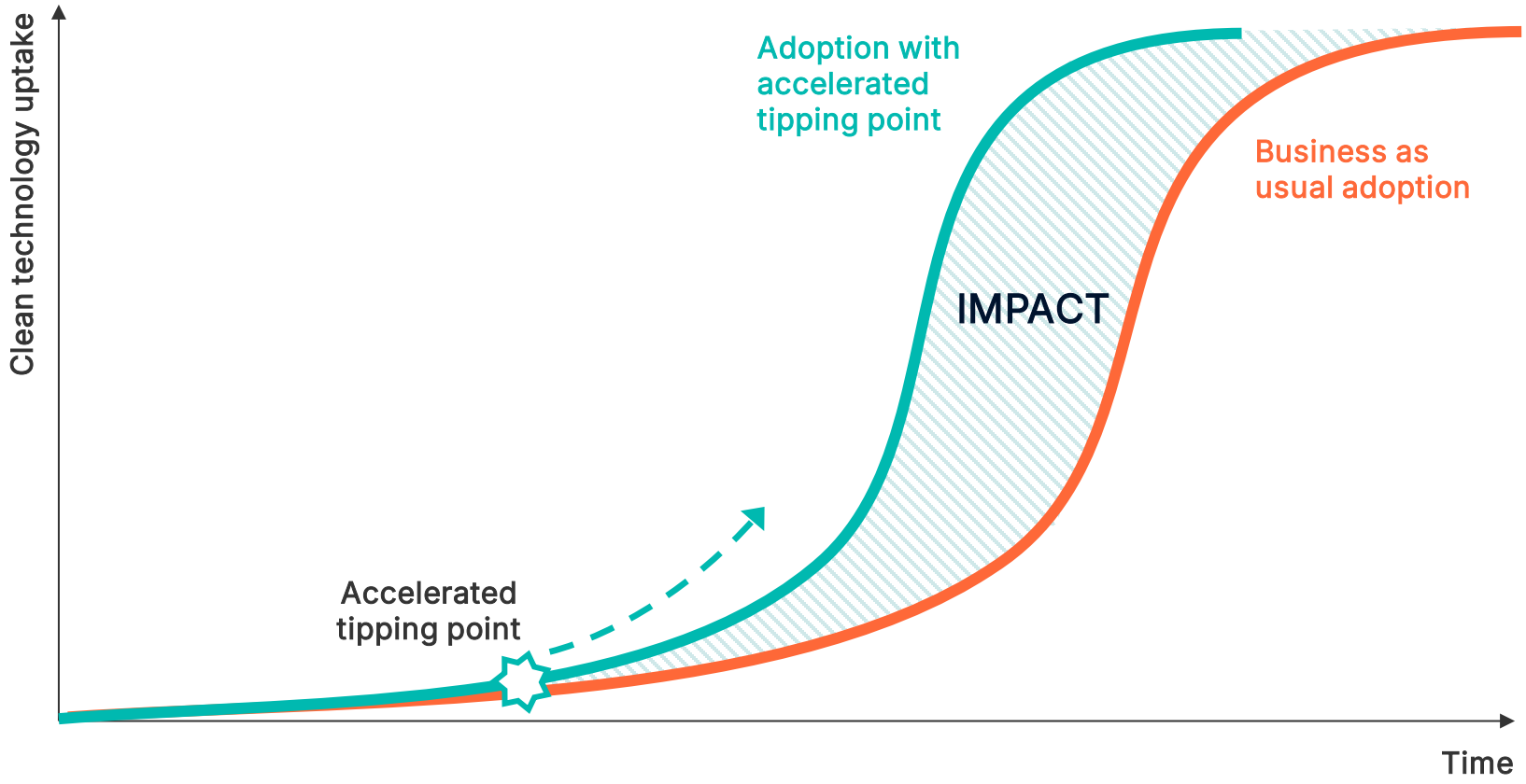
**Sources:** Systemiq (2023), The Breakthrough Effect

# Accelerating tipping points for climate technologies fast-tracks economic impact and helps reduce climate change

## Illustrative impact of accelerating a tipping point for a climate technology




**A tipping point happens when three conditions are met.** Working on these three conditions will accelerate a tipping point.

### 1 Affordable

The solution is financially viable for key decision-makers or users, often reaching cost parity or better.

### 2 Attractive

The solution is more desirable than the incumbent alternative, offering superior.

### 3 Accessible

The enabling infrastructure, technology, regulation, or supply chains are in place to scale deployment effectively.

Working on these three dimensions collectively and individually may accelerate the tipping point.



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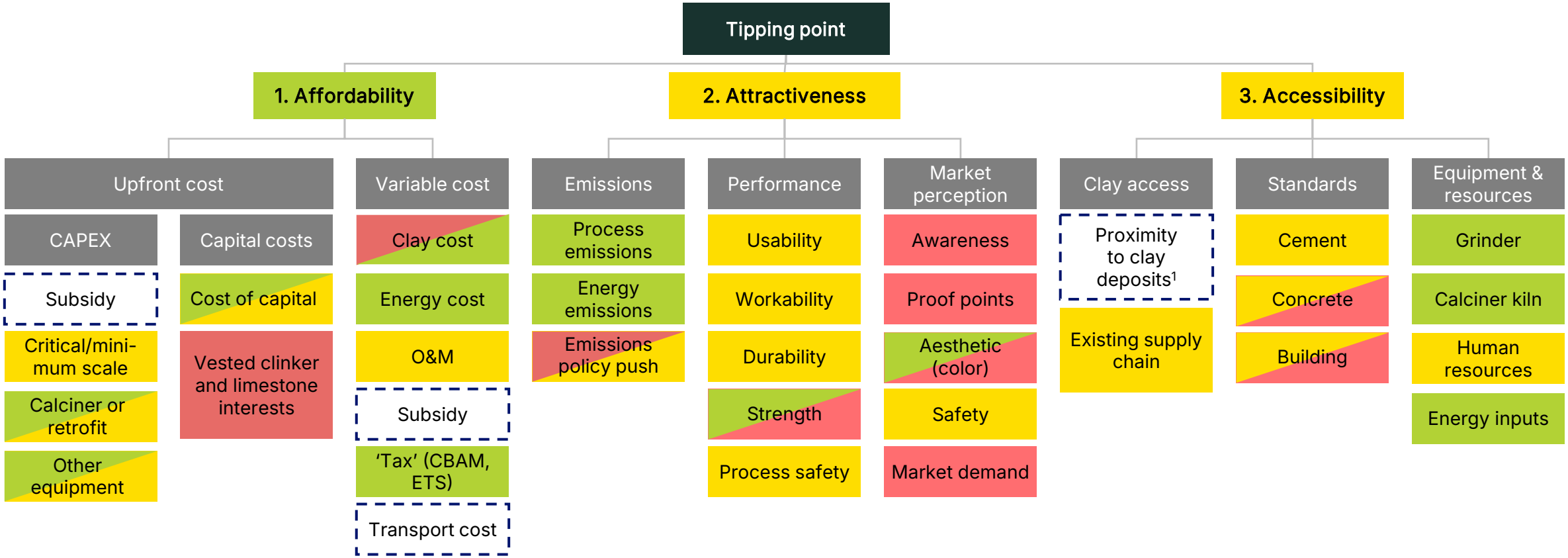
**Sources:** Systemiq (2023), The Breakthrough Effect

# Calcined clay-based cement can compete with OPC on affordability, attractiveness, and accessibility, but challenges remain to reach tipping point

## Preliminary mapping of challenges to reach a tipping point for Limestone Calcined Clay-based cement

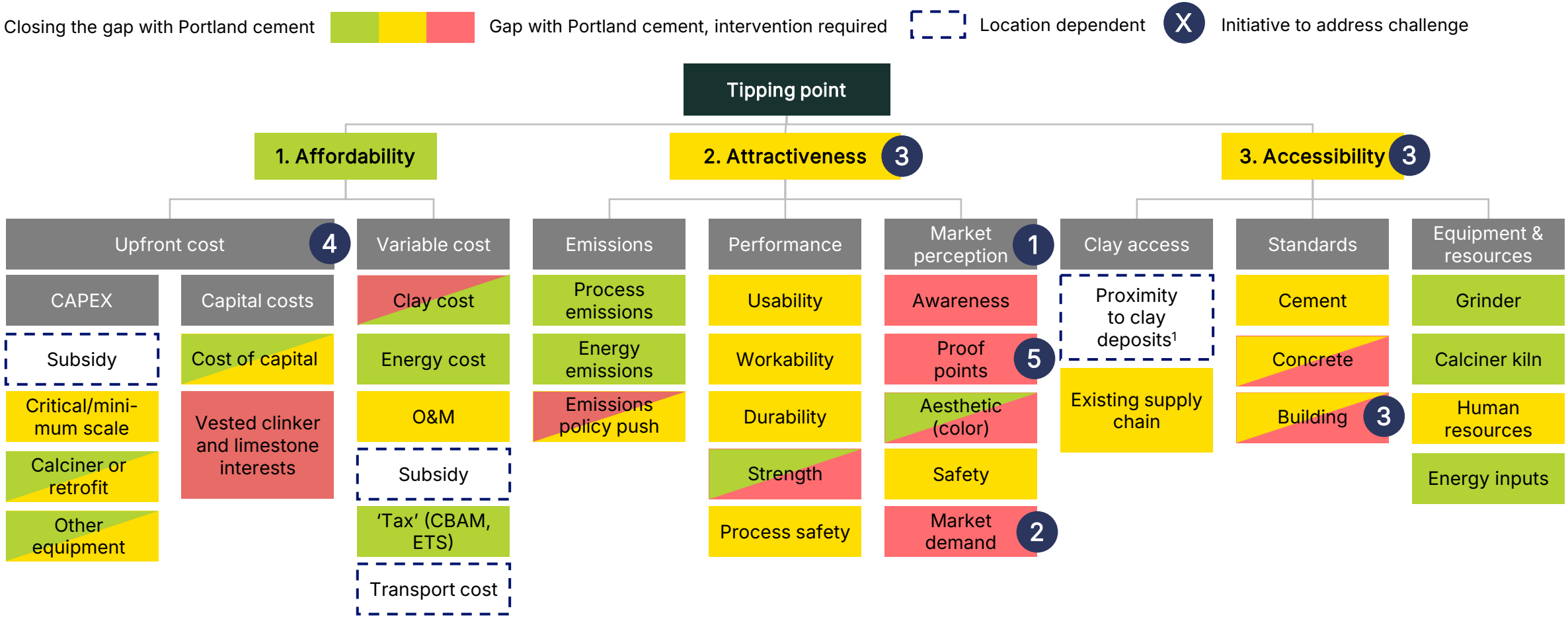
Closing the gap with Portland cement | Gap with Portland cement, intervention required | Location dependent




**Notes:** 1. Some limestone quarries have existing clay tailings with as a result that some calcined clay producers are not in need of finding new deposits.
**Sources:** Interviews with cement and calcined clay stakeholders in MENAT and beyond; Systemiq (2023), The Breakthrough Effect

# Specific initiatives which can scale production and demand of calcined clay

## Preliminary mapping of challenges to reach a tipping point for Limestone Calcined Clay-based cement




1 Awareness campaign

2 Expressing intent to work with calcined clay

3 Calcined clay policy activation

4 Validating the business case

5 Regional Lighthouse Projects

# Five different initiatives can stimulate supply and demand for calcined clay cement

| IMPROVING PERCEPTIONS | ENABLING LARGE SCALE PRODUCTION | POLICY INFLUENCE | DEPLOYING CAPITAL | SHOWCASING POTENTIAL |
|---|---|---|---|---|
| Awareness campaign | Expressing intent to work with calcined clay | Calcined clay policy activation | Validating the business case | Regional lighthouse project |
| Launch an awareness campaign, ensuring 100+ stakeholders throughout the value chain improve their awareness of calcined clay-based cement. This includes a focus on government stakeholders, finance, developers and construction engineers. | Develop a joint letter of intent signed by 50+ companies expressing intent to produce, specify or procure calcined clay cement.<br><br>*See range of demand signal on next Deep-Dive page* | Develop short-term policy asks through public-private working groups, ensuring they reach the right decision-makers to drive impact. | Launch a flexible online Business Case Tool based on LC3 models that allows stakeholders to simulate IRR, CAPEX, logistics, and (regional) ETS and CBAM exposure. | Bring together a consortium of developers and cement producers that will focus on delivering a 'Lighthouse Project' in their preferred region - creating a strong demand and policy signal while accelerating adoption across the built environment. |

**Sources**: Interviews with cement and calcined clay stakeholders in MENAT and beyond

# Different **demand signals** exist, ranging in level of commitments and complexity

## ENABLING LARGE SCALE PRODUCTION

| Demand aggregation | | | Policy tools or intervention | | Marketplace coordination | Bilateral/ Multi-lateral actions |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| **A Private Buyers Alliance** | **Private Buyers Alliance + LoI / MoU** | **Advance Market Commitment** | **Book and claim system** | **Regional Public Procurement Policies** | **Market intermediary** | **Direct bilateral long-term offtake agreements** |
| A **coalition of companies** that collectively signal future demand through 'Demand commitment letters' to catalyse supply-side investment, without specific contractual purchase commitments.<br><br>E.g., First Movers Coalition, ConcreteZero | **As per 1 + MoU** between specific developers and producers to procure aggregated demand<br><br>E.g., Vattenfall and Cemvision have entered an agreement (LOI) for the development and future supply of near-zero emission cement | A **binding financial pledge specifying cost and quantity** that guarantees a future market for a product to accelerate its development and scale-up. This could be bilateral or collective.<br><br>E.g., Innovate UK's Concrete Commitment Cohort; 7-year binding agreement between Stegra and ZF | A system **enabling companies to buy verified emissions cuts** from low-carbon **producers without a direct physical supply** link.<br><br>In the case of using SCM's to decarbonise cement this might not be as effective.<br>E.g., GCCA initiative | **Governments mandate or incentivise** the use of low-carbon cement (including calcined clay-based cement) in **public infrastructure projects.**<br><br>E.g., Updating the 'level 3' regional IDDI[1] Green Public Procurement (GPP) Pledge, RMI's Steel Procurement | A **coordinated platform** that aggregates demand from private buyers to purchase verified emissions reductions, helping scale up investment.<br><br>E.g., H2 Global using a double auction system | Bilateral offtake agreements between construction companies and concrete and cement producers.<br><br>Multilateral offtake agreements could also be pursued, including specifiers (developers, architects, engineers) in the process. |

**Level of commitment** — N/A

**Legal & organisational complexity** — N/A



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**Notes:** 1. Industrial Deep Decarbonisation Initiative (IDDI)
**Sources:** This overview has been created together with representatives from the Mission Possible Partnership, Concrete Zero and the First Movers Coalition.

# 3

## Calcined clay
## Call to action

THE ASK

# Help accelerate **production and use** of calcined-clay based cement

**Together work towards demand and supply for calcined clay-based cement**

**Developers:**
work towards offtake for calcined clay

**Producers:**
work towards FID for a calcined clay production facility

## What is the ask?

### Understand the potential of calcined clay

- Endorse that calcined clay is a critical material for a viable decarbonisation pathway for cement & concrete sector
- Explore how your organisation can contribute to its scale-up

### Understand role you and your organisation can play

- Test concept within your organisation
- Nominate representative(s) within your organisation with the mandate to engage in further discussions, exploring technical and financial feasibility

### Explore further

- Join efforts with stakeholders across the value chain to unlock shared opportunities
- Reach out to concrete@missionpossiblepartnership.org and cement@systemiq.earth for any queries or interest in getting involved

DEEP DIVE

# MENAT region deep-dives on cement decarbonisation

## Approach

- Calcined clay production and demand is growing globally.
- While the opportunity is global, actual investments must be made locally.
- This project reviewed several markets in Menat to determine the most impactful decarbonisation opportunities for construction materials.
- Local conditions must be favorable to support the first wave of investments - Türkiye, UAE[1] and Saudi Arabia **were further analysed**

# We reviewed several markets in MENAT focusing on their potential for low-carbon cement

### General opportunity in MENAT, with focus on Türkiye, UAE and Saudi

Map of MENAT region

Focus regions

### Türkiye

Focus on **scaling calcined clay**, given abundant suitable clays, strong construction sector and large cement sector/ powerhouse

### UAE[1]

Focus on **scaling calcined clay,** from neighboring region Oman and **synergies with CCS-based cement**, given large domestic market and availability of low-cost capital

### Saudi Arabia

Focus on **scaling calcined clay**, given pipeline of mega projects with sustainable ambitions, abundant suitable clays and availability of low-cost capital

**Notes: 1.** For the UAE there are no kaolinitic clay sources available within the country, but there is a logical route to use such clays from Oman. Therefore, te regional deep-dive for the UAE also focuses on CCS-based cement in this specific region.

DEEP DIVE

# Türkiye

JUN 2025

# Türkiye has the potential to become a supplier of low-carbon cement by scaling their calcined clay production

### Abundant suitable clays and potential to repurpose existing clay supply chain

3rd global largest clay[1] producer in 2022 with large ~300-600 Mt clay reserves.

### Declining GGBS supply, making calcined clay a strategic choice

50% reduction in global GGBS supply expected with the phase-out of blast furnaces. Calcined clay can therefore be seen as a 'strategic play'.

### Large local demand and policy ambition to decarbonise cement

Türkiye is large cement consumer, especially considering its reconstruction efforts after the earthquake in 2023. With the upcoming ETS, there is a ambition for the Turkish cement sector to decarbonise.

### 2nd largest exporter of cement and growing cement demand

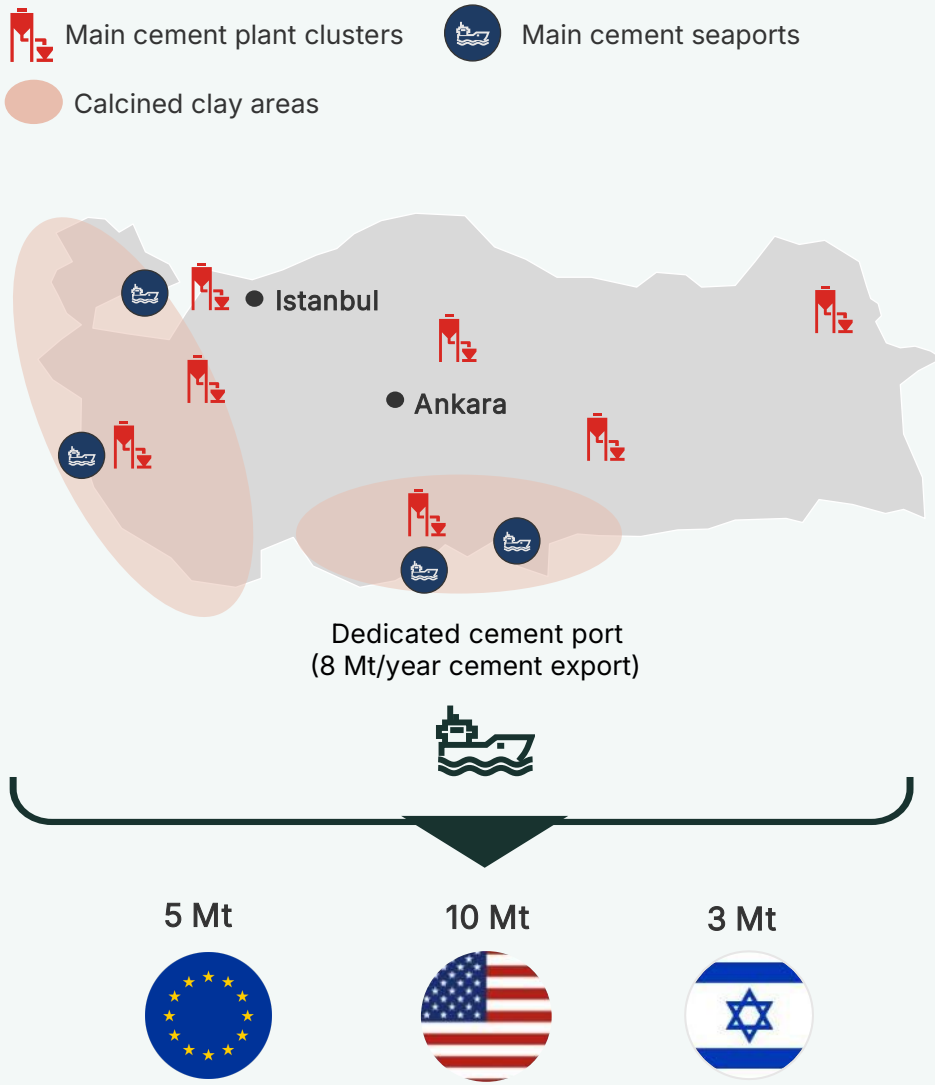
>10% of global cement exports, >30% of European imports, 65 Mt/year cement demand is projected to grow by 3%[2] annually by 2030

### Large export which is exposed to CBAM

27 Mt cement export of which 5 Mt ($0.8 billion) exposed to CBAM, for which certificate purchase will be required from 2026 onwards.

**Notes: 1.** Kaolin clay specifically; **2.** Based on average forecast clinker production growth
**Sources:** Bilim (2018); CEMBUREAU (2023); International Cement Review (2023); General Directorate of Mineral Research and Exploration (2013); Global Cement (2024); Global Cement (2024); PWC (2024); Turkish cement (2024); Turkish Cement (2024); Soilgrids (2024); Systemiq analysis; YUKAMI (2022).

## Calcined clay is crucial for decarbonising cement, and Türkiye is well-positioned to supply it...





31

# An awareness campaign, demand signal and capital deployment are key initiatives to scale calcined clay in Türkiye

High relevance for region | Medium relevance for region | Lower relevance for region

| Initiatives to accelerate low-carbon cement | | Key impact of initiatives in the region | Level of impact in region |
|---|---|---|---|
| 1 IMPROVING PERCEPTIONS | Awareness campaign | Awareness ranging from clay selection, testing, and processing for some stakeholders, to clarifying the maturity and performance of calcined clay has been mentioned to boost investment or demand confidence | |
| 2 ENABLING LARGE SCALE PRODUCTION | Expressing intent to work with calcined clay | While other established market players expect that they can convince their current clients others stress the importance of clear demand signals to unlock investments. Expressions of intent from key actors could serve as a catalyst for industry-wide scaling of calcined clay cement. This is particularly impactful in geographies with ready clay access. | |
| 3 POLICY INFLUENCE | Calcined clay policy activation | Although local building codes do not block adoption, the absence of funding mechanisms and public procurement incentives slows uptake. Targeted policies to embed calcined clay in public tenders and funding instruments would drive meaningful market traction. | |
| 4 DEPLOYING CAPITAL | Validating the business case | Stakeholders highlight a need for deeper insights into cost structures and logistics and to identify additional value drivers to the business case. Relatively short payback periods make LC3 highly attractive under certain conditions. Business case clarity remains essential to secure capital and understand sensitivity towards different input parameters. Highlighting success stories and offering investment templates can boost confidence. | |
| 5 SHOWCASING POTENTIAL | Regional lighthouse project | Demonstration projects are important to validate performance and economics in local conditions. While other established market players expect that they can convince their current clients others stress the importance of showcasing LC3 in action to enhance awareness, support adoption, and influence public and private procurement choices. | |



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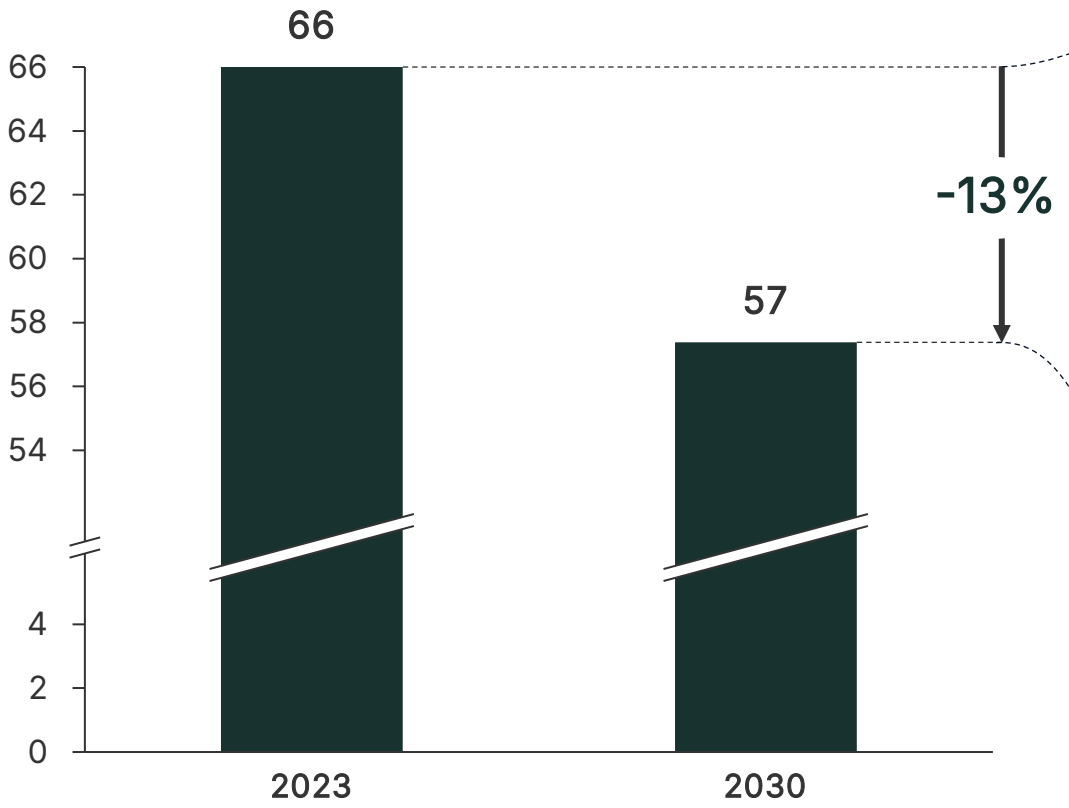
**Sources:** Stakeholder interviews

DEEP-DIVE

# Türkiye aims to cut cement emissions by ~13% by 2030 which can be achieved by scaling cement replacements

## Low-carbon pathway Türkiye up to 2030

Mt $CO_2$




## Decarbonisation options for cement in Türkiye up to 2030

% emission reductions estimated

**-5%**

Energy **efficiency improvements** and switching to **alternative fuels** only get us thus far...

**0%**

...There are currently **no CCS-based** cement plants coming online by 2030

**-8%**

...Achieving it targets through **cement-replacement materials** will provide the most cost-effective solutions

With even more emission reduction possible

**Sources:** Ministry of Industry and Technology (2023); MPP and Systemiq analysis



33

DEEP DIVE

# The UAE

FEB 2025

# The UAE has the prerequisites to become a pioneer supplier of CCS-based cement

### The UAE relies heavily on CCS[1] in its decarbonisation efforts

32% (43.5 Mt $CO_2$) of emissions reduction to achieve net zero by 2050 through CCS and several projects already in the pipeline (3 $MtCO_2$ capture capacity)

### Large and growing domestic cement demand and exports

Large cement exports (~10 Mt in 2022) and domestic demand (~11 Mt in 2022), the latter growing with construction market at 4% per year

### Potential for cost -competitive $CO_2$ transport and storage

Large-scale $CO_2$ storage sinks in the region[2], presence of oil & gas companies with know-how and costs roughly half of that in EU (~$25/$tCO_2$)

### Clean and low-cost power can supply CCS energy demand

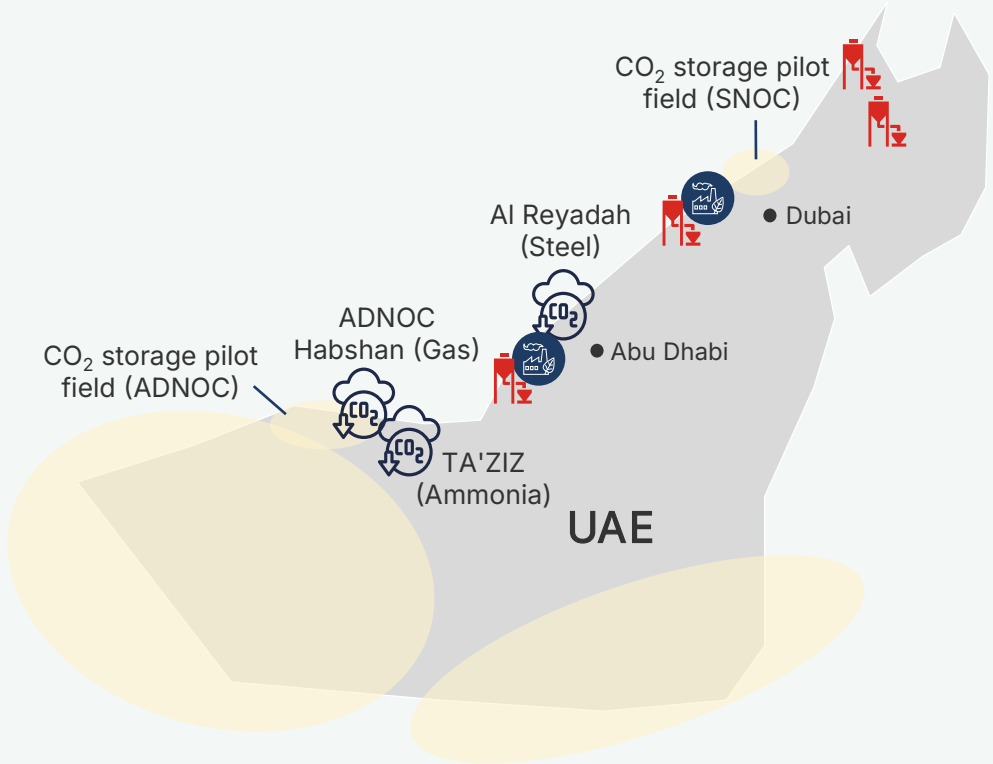
Low-cost solar energy (~$30/MWh) with targets to triple renewable energy capacity by 2030, enabling energy-intense CCS installations

### Availability of low-cost capital and financial instruments

Advancing sustainable finance market with the financial sector having pledged to mobilize AED 1 trillion in sustainable finance by 2030

**Calcined clay is crucial for decarbonising cement, and the UAE is well-positioned to supply it...**

- Cement plant clusters (UCC, LaFargeHolcim, UltraTech, Arkan Building Material)
- Industrial Hubs
- Existing CCU/S projects
- Favourable $CO_2$ storage locations (aquifers / gas fields)



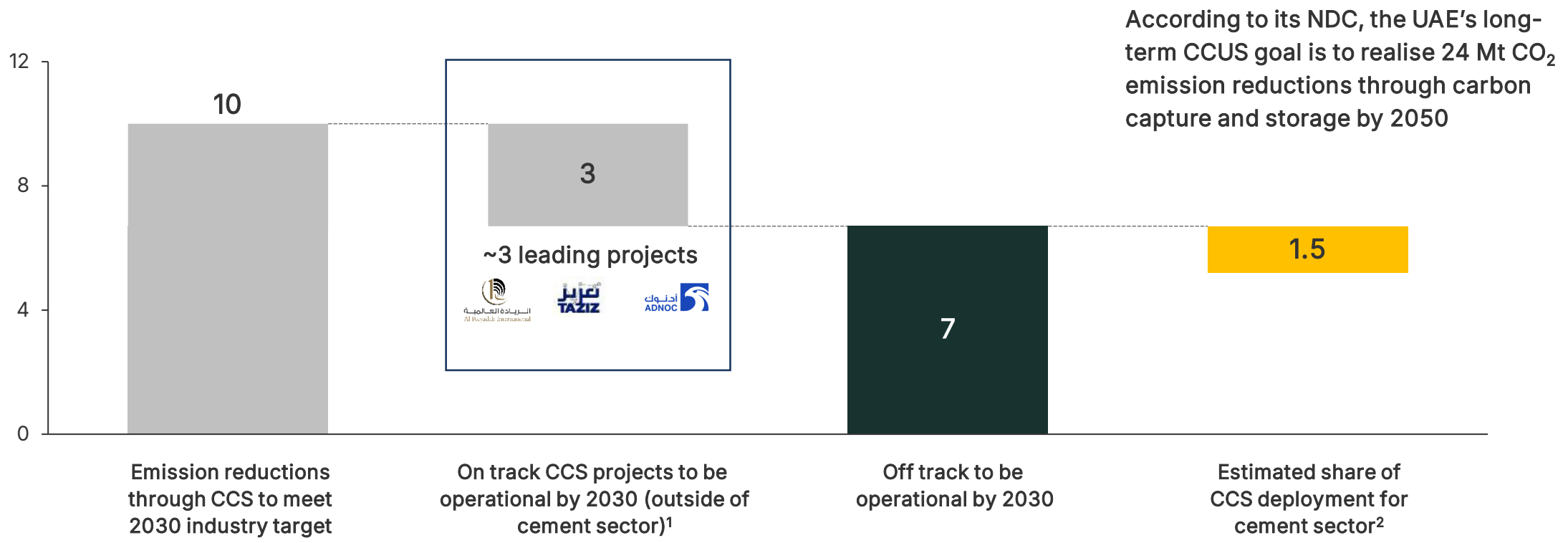

**Notes:** 1. Carbon Capture & Storage; 2. $CO_2$ transport infrastructure is under-developed.
**Sources:** DNV (2024); Imen Gherboudj, Hosni Ghedira (2016); IRENA (2019); KAPSARC (2023); Ministry of Energy & Infrastructure (2023); Ministry of Climate Change & Environment (2020); OGCI (2022); Sumitomo Corporation (2023); Ye, Jing et al. (2023).


35

# The UAE has launched several CCS projects, yet no projects exist in the cement sector – other levers must be pursued

## CCS projects for UAEs industrial sectors

Mt $CO_2$, by 2030




**Notes:** 1. Included projects: ~0.8 Mt $CO_2$ (CCU/S DRI-EAF, Al Reyadah), ~1 Mt CO2 (ammonia, TA'ZIZ), and 1.5 Mt $CO_2$ (fats processing, ADNOC). 2. Assumed that 13% of UAE targeted industrial emissions reduction should come from the cement sector (based on MPP regional modelling work).

**Sources:** MPP (2024); Global CCS Institute (2024); UAE MoCCE (2023); UAE MoIAT (2023).



36

# Policy activation and the development of regional Lighthouse project(s) are key initiatives to scale calcined clay in the UAE

High relevance for region | Medium relevance for region | Lower relevance for region

| Initiatives to accelerate low-carbon cement | | Key impact of initiatives in the region | Level of impact in region |
|---|---|---|---|
| 1 IMPROVING PERCEPTIONS | Awareness campaign | Local stakeholders in the UAE would benefit from increased awareness on the technical performance and cost-effectiveness of calcined clay. Concerns remain around clay suitability and availability – especially given most projects now are focused on clay from Oman. | Medium |
| 2 ENABLING LARGE SCALE PRODUCTION | Expressing intent to work with calcined clay | In the UAE, public procurement pilots and private sector signals are essential to create market pull. Specifically, developers highlight a lack of access to short-term supply and diverse set of suppliers. Expressing demand-side commitment can encourage producers to explore supply-side readiness | Medium |
| 3 POLICY INFLUENCE | Calcined clay policy activation | Building codes are critical in the UAE. While calcined clay is not prohibited, limited policy support slows adoption. Including LC3 in green public procurement standards and updating codes to support innovative materials could accelerate uptake. | High |
| 4 DEPLOYING CAPITAL | Validating the business case | This initiative is not a priority for the UAE due to strong capital access. However, stakeholders note the building sector's limited cost flexibility and challenges with multi-sourcing. A targeted business case—highlighting clay supply, GGBS substitution, and carbon savings—could drive investment. | Lower |
| 5 SHOWCASING POTENTIAL | Regional lighthouse project | A regional demonstration project could validate performance under UAE conditions and showcase its potential to key government stakeholders. Such a pilot project is seen as a key unlock. | High |



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**Sources:** Stakeholder interviews

DEEP DIVE

# Saudi Arabia

FEB 2025

# Saudi Arabia has the prerequisites to become a supplier of low-carbon calcined clay cement

### Abundant suitable clays and potential to repurpose existing clay supply chain

Saudi Arabia possesses suitable clay reserves, which are currently undervalued and often regarded as waste. Significant clay deposits across the country (e.g., 20 Mt in Khushaym Radi and 50 Mt in Yanbu Al Bahr), often near existing cement clusters, existing production capacity of ~60 kt clay

### Declining supply of alternative cement replacements and rising prices

Availability of alternative cement replacements (GGBS[1] and fly ash) is shrinking with 50% in the coming 15 years which is likely to cause price spikes

### Large and growing domestic cement demand

High per-capita consumption ~ 1500 kg cement/year and large total consumption of ~ 47 Mt cement per year, expected to grow at 7% CAGR over the next 4 – 5 years. Additionally, Saudi Arabia's many prestigious Vision 2030 projects are increasingly emphasizing sustainability

### Pipeline of mega projects with sustainable ambitions

Prestigious Vision 2030 projects such as NEOM, The Red Sea Project and Diriyah Gate drive the construction industry and have expressedd interest in sustainability

### Large availability of low-cost capital

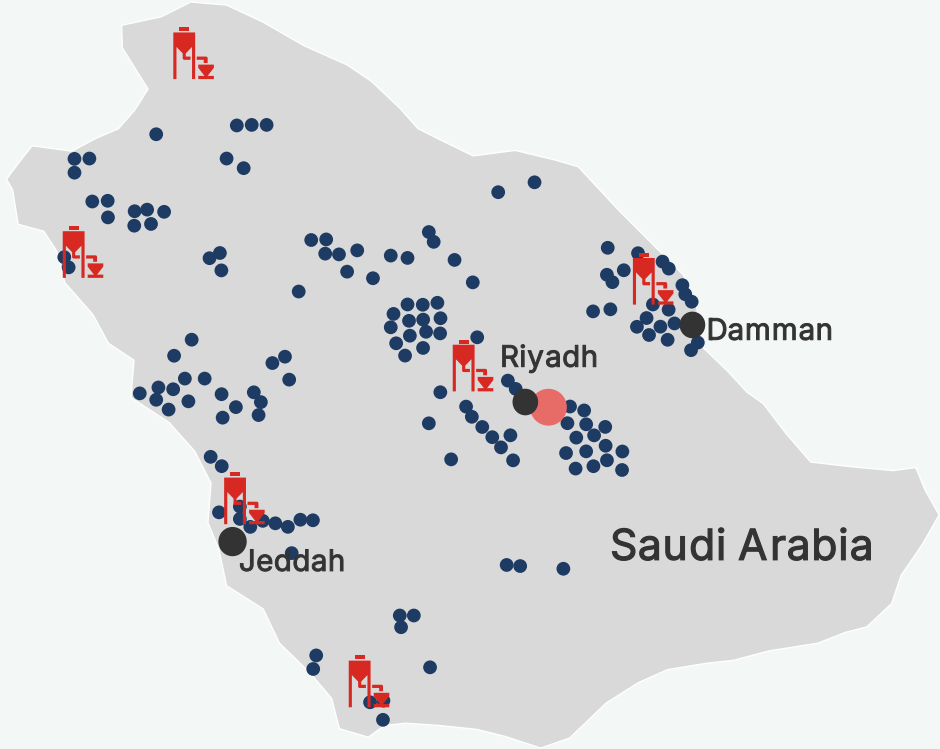
Saudi Arabia's sovereign wealth fund is planning ~$20 billion of low-carbon investments with a particular focus on low-carbon buildings and issued the first 100-year green bond

## Calcined clay is crucial for decarbonising cement, and Saudi Arabia is well-positioned to supply it...

Main cement plant clusters (Arabian Cement, Najran Cement, Qassim Cement, Saudi Cement, Southern Province Cement, Yanbu Cement, Yamama)

Known clay deposits

Announced calcined clay production




**Notes**: 1. Ground Granulated Blast Furnace Slag
**Sources:** Almohandis (1993); ESG (2024); Global Blast Furnace Tracker (2024); Global Cement (2024); IEA (2024); Kingdom of Saudi Arabia (2016);

# Awareness campaigns could support the scaling of calcined clay in Saudi Arabia

High relevance for region | Medium relevance for region | Lower relevance for region

| Initiatives to accelerate low-carbon cement | | Key impact of initiatives in the region | Level of impact in region |
|---|---|---|---|
| 1 IMPROVING PERCEPTIONS | Awareness campaign | Large-scale construction projects are risk-averse and reluctant to adopt unfamiliar materials. Industry stakeholders emphasise the need for tried-and-tested solutions. An awareness campaign, showcasing calcined clay-based cement as such a commercial solution could therefore increase adoption. | |
| 2 ENABLING LARGE SCALE PRODUCTION | Expressing intent to work with calcined clay | Cement producers are unlikely to prioritise emissions without strong demand signals. As one stakeholder noted, “It’s a chicken-and-egg problem: suppliers are prepared to invest only if they can get demand.” Clear commitments from major buyers could help trigger supplier investment and unlock the project pipeline. | |
| 3 POLICY INFLUENCE | Calcined clay policy activation | While current regulations may not actively block calcined clay, the lack of enabling policy frameworks or incentives delays action. Targeted policy measures could shift the balance but are not currently seen as a major lever. | |
| 4 DEPLOYING CAPITAL | Validating the business case | Cement producers in Saudi Arabia are conservative and hesitant to invest in low-carbon materials if it means compromising on timelines or costs. Strengthening the business case with local cost data and reliable project benchmarks could help overcome this resistance. | |
| 5 SHOWCASING POTENTIAL | Regional lighthouse project | A regional demonstration project could help address the lack of local experience and validate performance in Saudi-specific contexts. This could reduce perceived risk for large-scale buyers. | |

**Sources:** Stakeholder interviews

DEEP-DIVE

# Saudi Arabia's many prestigious Vision 2030 projects are increasingly emphasising sustainability

## NEOM

$350B urban development (roughly the size of Belgium), which includes the 170 km linear city The Line, port-industrial cluster Oxagon, several holiday destinations and large renewable energy projects

## The Red Sea Project

A $17B luxury regenerative tourism destination spanning 28,000 sq km and over 90 islands.

## Diriyah gate

A $64B cultural and heritage development anchored around the At-Turaif UNESCO World Heritage Site

**CarbonCure partners with Saudi in construction of NEOM**

Home / NEOM's Oxagon leads the way in sustainable industrial revolution

NEOM's Oxagon leads the way in sustainable industrial revolution

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The hydrogen-producing programme of Saudi giga project Neom will create eight tonnes of green hydrogen a day, it has been announced.

**World's largest solar microgrid rises along Saudi's Red Sea**

The Red Sea project is poised to be the world's first fully clean energy-powered destination

**Diriyah aims to be 'shining example' of sustainability**

By Andy Sambidge | June 28, 2022, 12:01 AM



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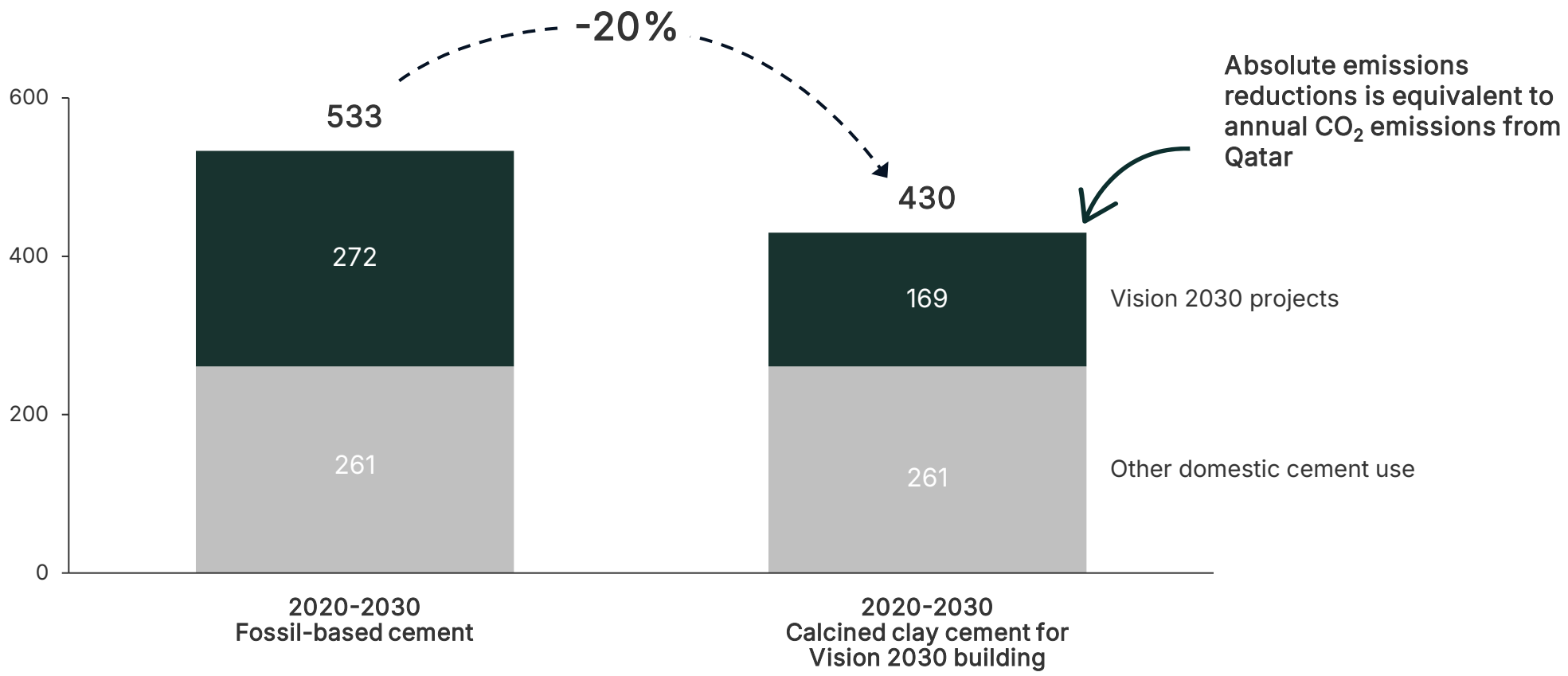
**Sources:** NEOM (2024); Mechanical Electrical Plumbing (2024); AGBI (2024); CNBC (2024); Arab News (2024); PIF (2022); E+Eleader (2024); Gulf Business (2024); AGBI (2024); Knight Frank (2024); Expert interviews

# Adopting calcined clay cement in Vision 2030 projects would cut 20% of Saudi's total cement emissions

## Estimated cement emissions between 2020 and 2030

Mt $CO_2$




**Notes**: Key assumptions include remaining project value estimate (Knight Frank, 2024); concrete costs at 7% of total building costs (MPP analysis); average concrete cost in Saudi Arabia: $50/m³ (Zwaya Green, 2024); cement $CO_2$ emission intensity: 0.82 $tCO_2/t$ (Climatiq, 2022); domestic demand: 47 Mt (Global Cement, 2024); emissions Qatar: 130 Mt (CEIC)

**Sources:** Climatiq (2022); CEIC (2023) Global Cement (2024); Knight Frank (2024); MPP analysis; Zwaya (2024)



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