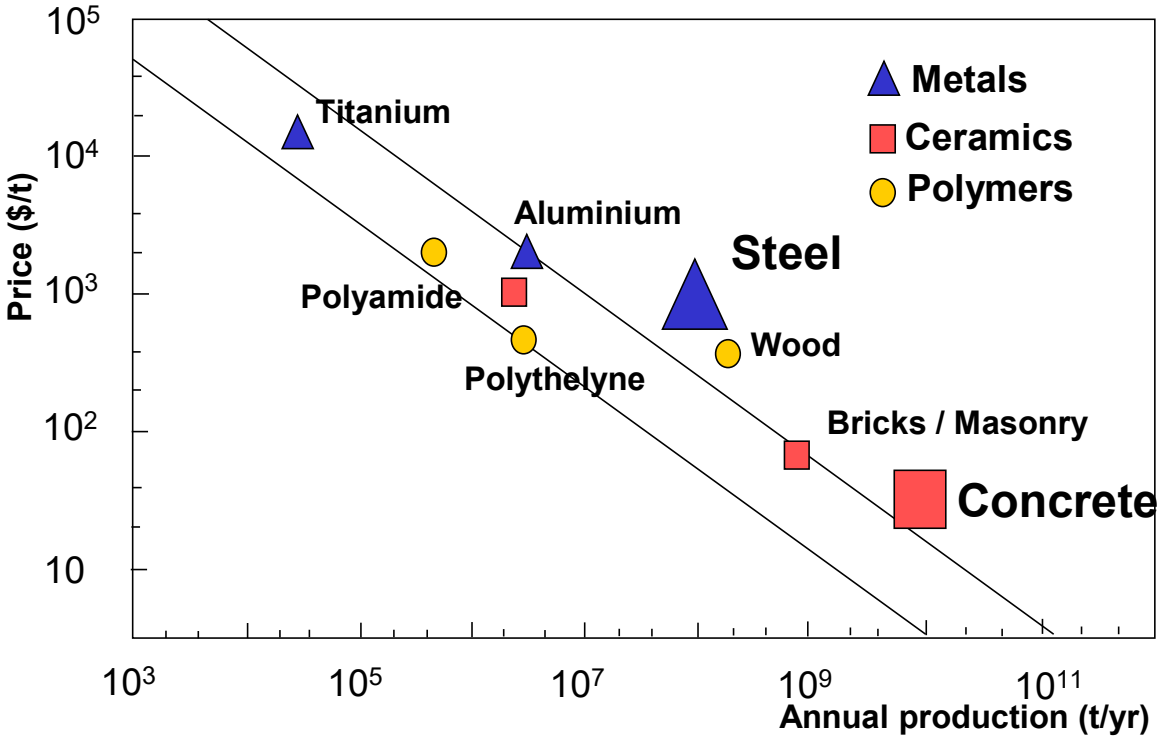
Low Carbon Cement – The LC^3

Image credit: Patrick Hendry/Unsplash

ANGAN 2022: Making the Zero-Carbon Transition in Buildings
14 September 2022
New Delhi

Context

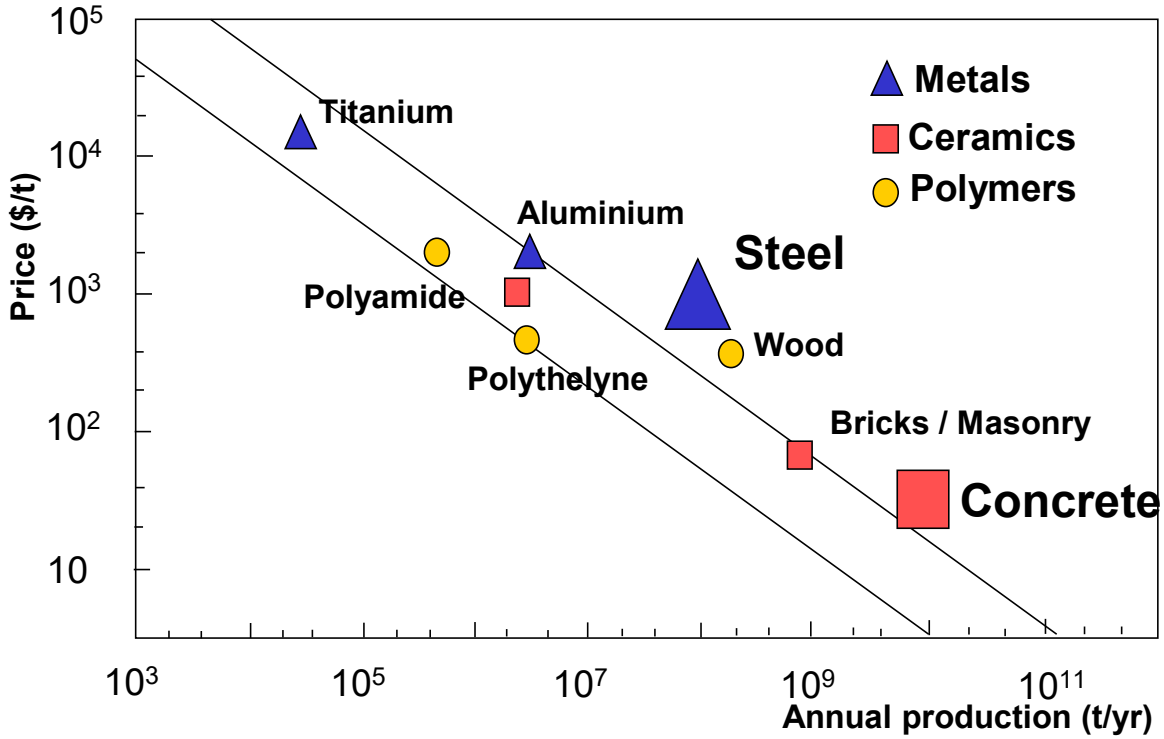
Concrete is by far the most used material in the world



Source: *INTRODUCTION à LA SCIENCE DES MATÉRIAUX, Kurz,Mercier, Zambelli,. PPUR , 3rd ed 2002*

Context

And yet, the enormous volumes used means that concrete production accounts for some **7-9%** of the man-made CO_2 worldwide



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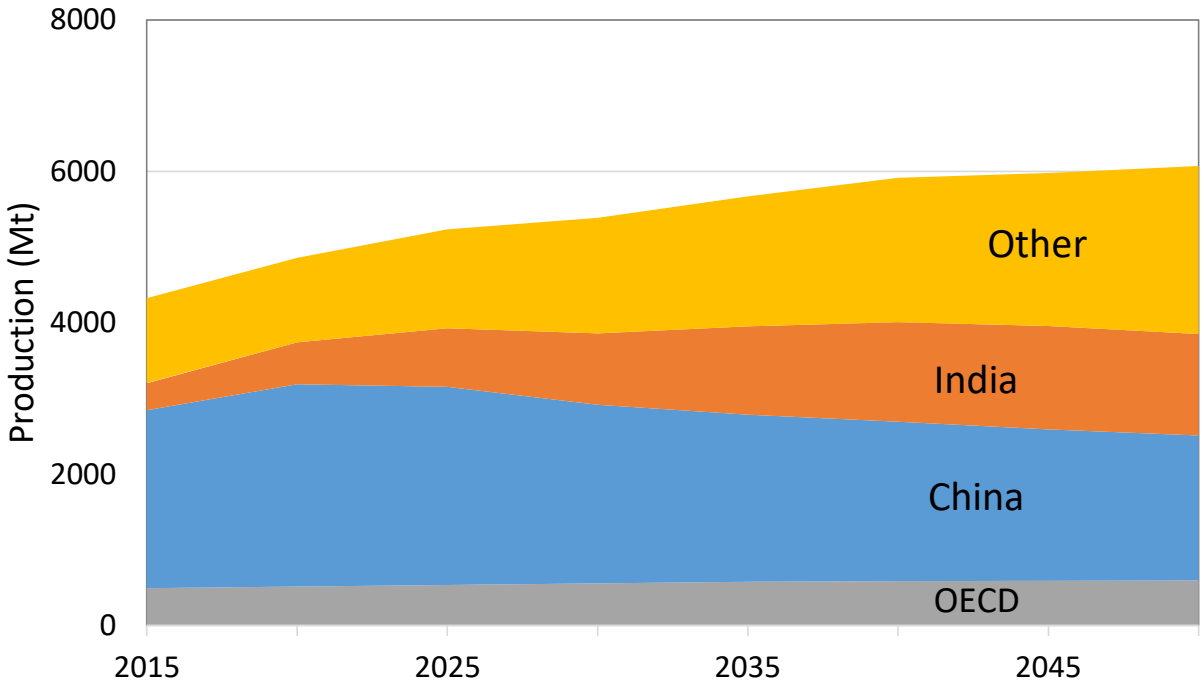
a 1% reduction in CO_2 emissions associate with cement and concrete would have the same overall impact as a 100% reduction for steel production

Context

And demand is forecast to rise:

to meet the demand of a growing world population



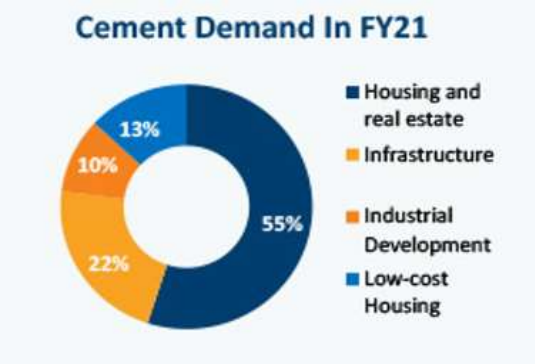
Context

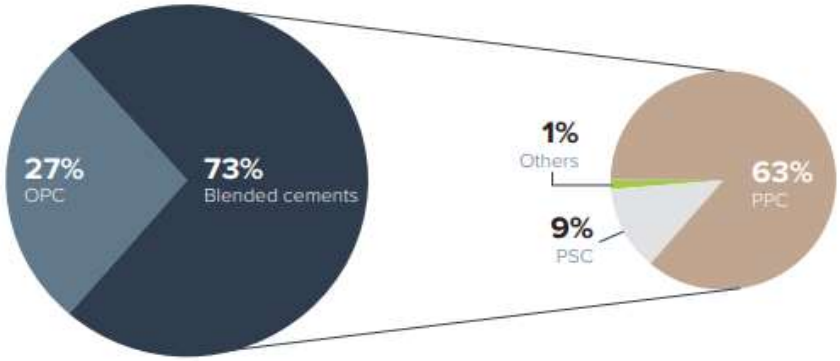
And demand is forecast to rise:
to meet the demand of a growing world population

- Urbanization and need of houses and infrastructure

Status of the Indian cement industry

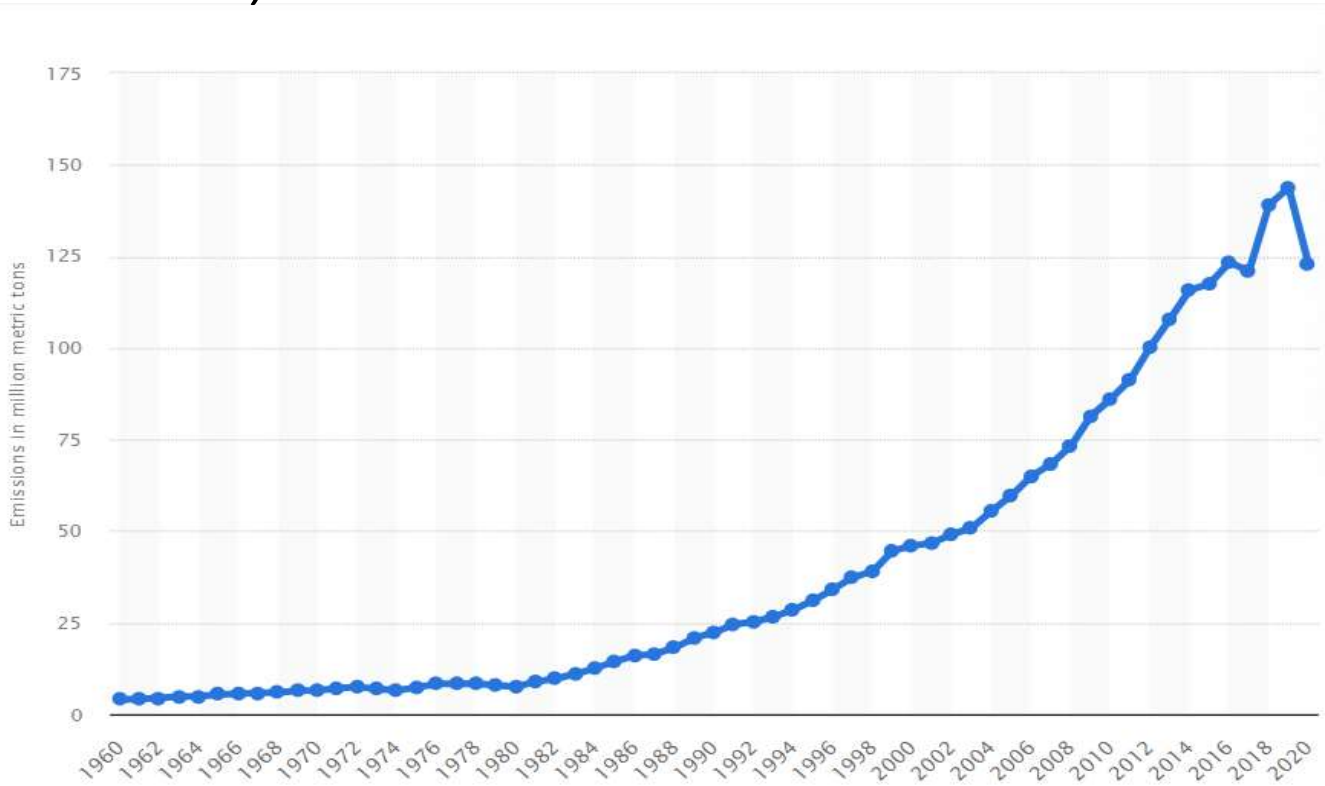
- Second largest producer of cement – 7% of the global demand
- Around 381 MioT in FY22
- 12% YoY growth
- Strong demand – affordable housing, infrastructure and smart cities
- One of the greenest cement production in the world – fly ash and slag
- 7% contribution to India's total process CO_2 emission



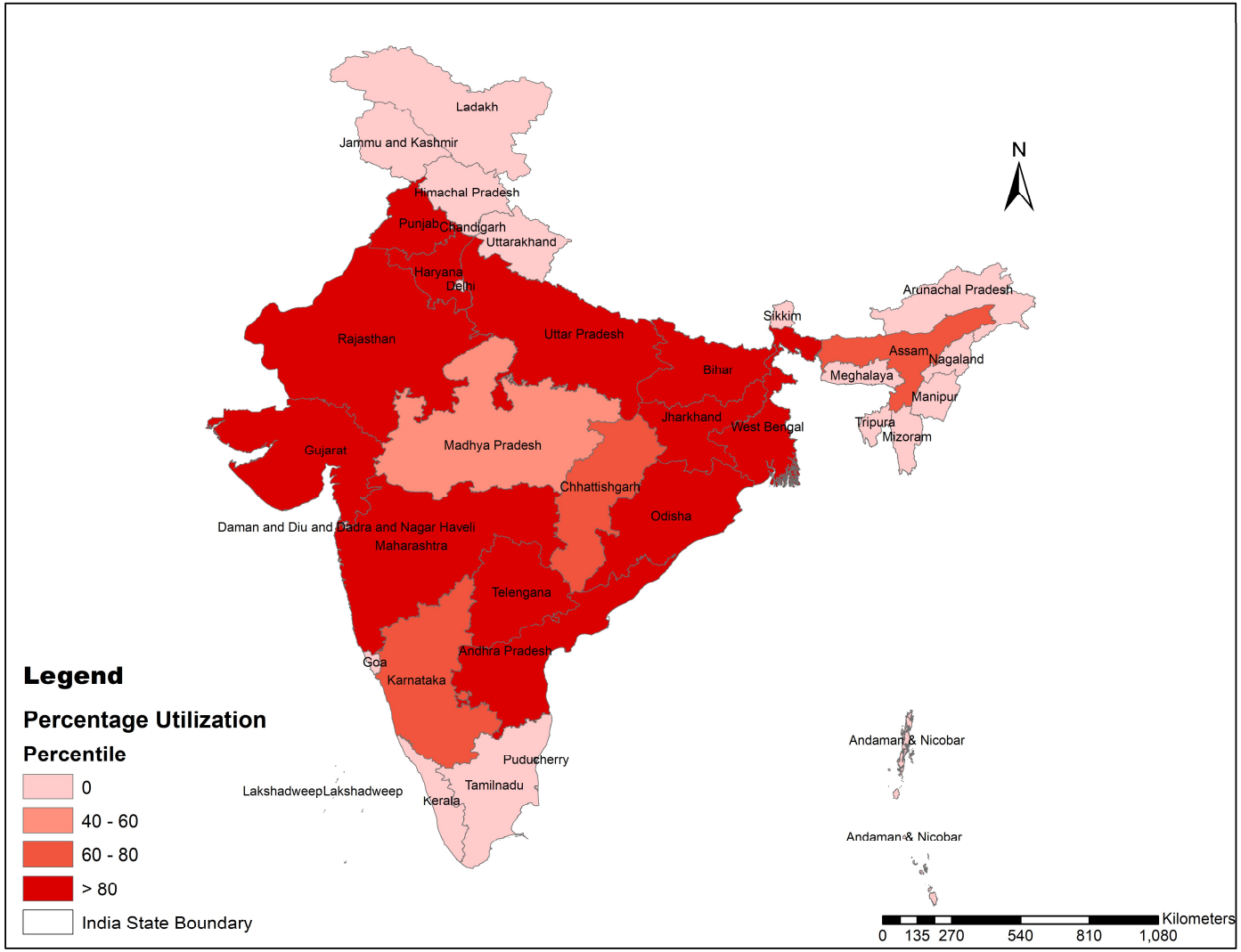


Status of the Indian cement industry

CO_2 emissions from the manufacture of cement in India from 1960 to 2020
(in million metric tons)

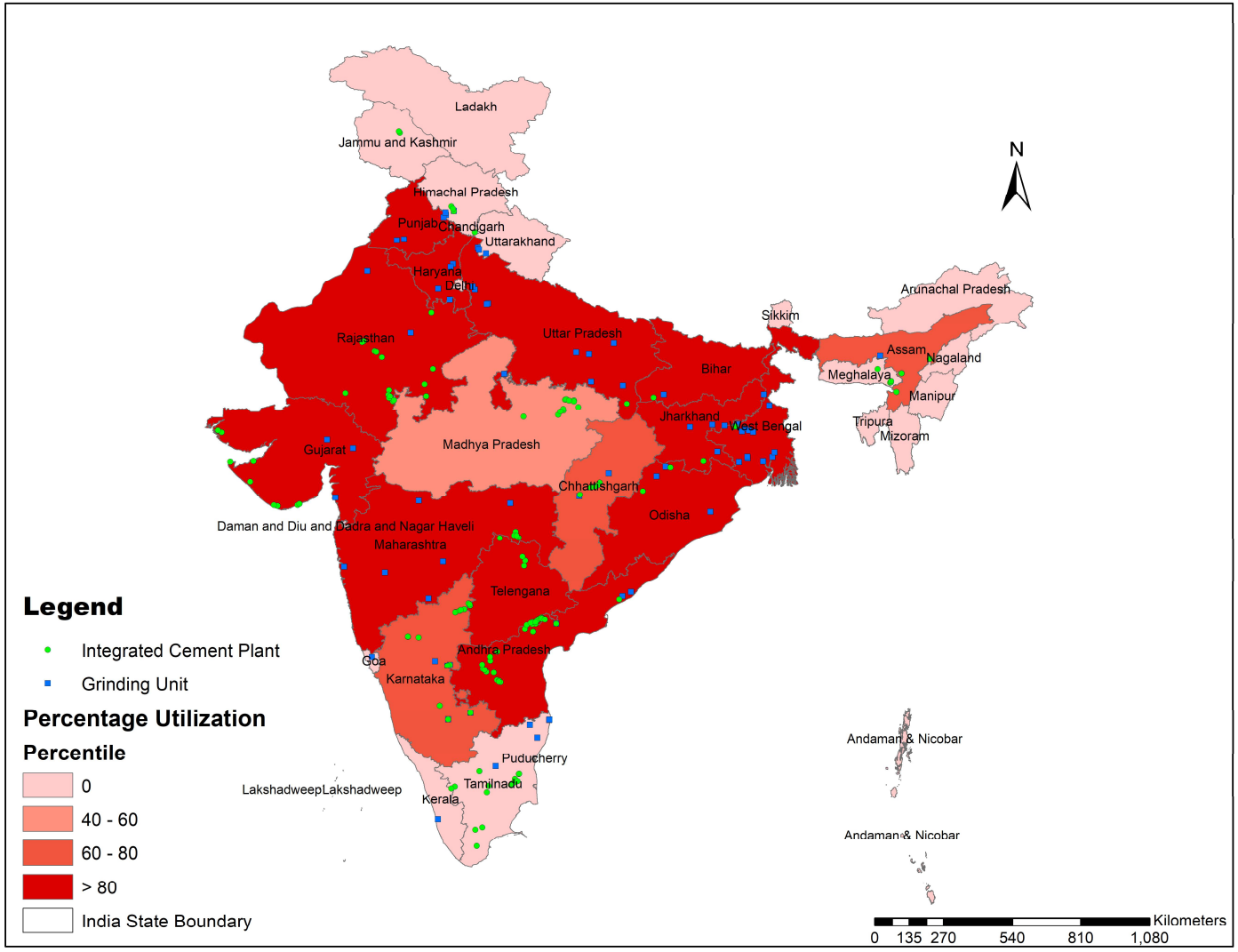


Status of the Indian cement industry



Availability of fly ash

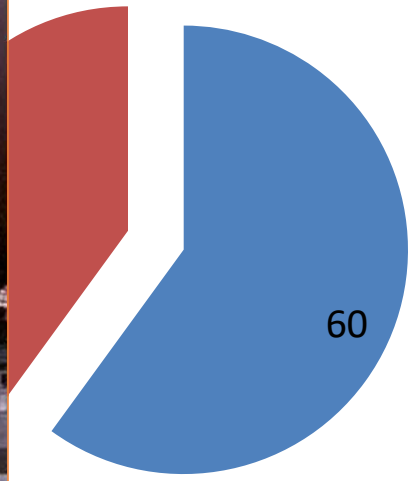
Status of the Indian cement industry



Availability of fly ash

Origin of CO_2 emissions in cement production

1 tonne of cement leads to emission of 650 – 900 kg CO_2



Decreasing "chemical" CO_2 will mean changes in the *chemistry* of the cement: therefore its reactions and potential performance

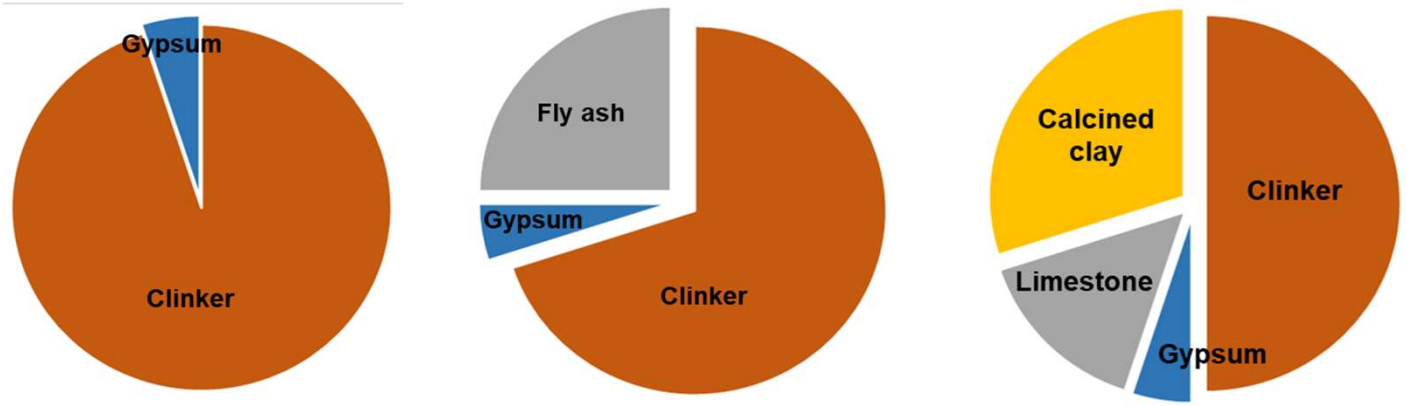
A more realistic solution

Only material really potentially available in viable quantities is calcined clay.

Blend containing combination of calcined clay and limestone are particularly interesting: Swiss led LC^3 project supported by SDC: *Swiss Federal Government Agency for Development and Cooperation*

Limestone
Calcined
Clay
Cement
LC3

What is LC^3?

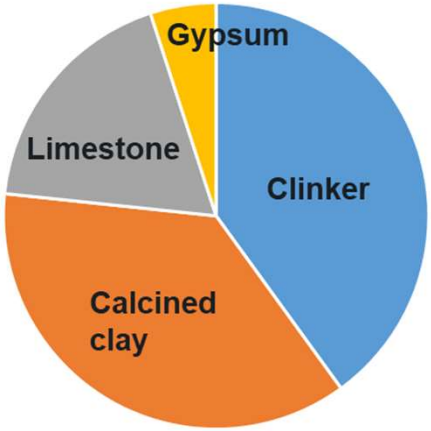


OPC PPC LC^3 50

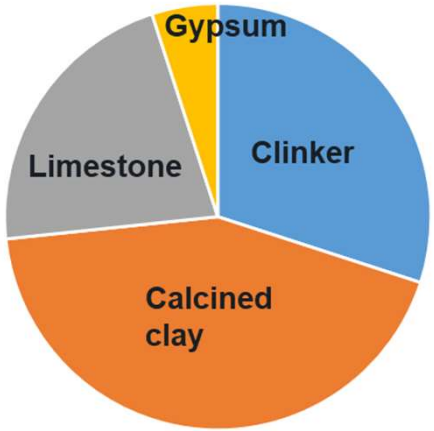
LC^3: Advantages

- Clinker factor reduced to 50%
- Use of moderate quality clays and low grade limestone resources
- Low temperature calcination of kaolinitic clays (800^0C)
- Saving of upto 40% CO_2 emissions compared to Ordinary Portland Cement

What is LC^3?



$LC^3$40



$LC^3$30

LC^3: Advantages

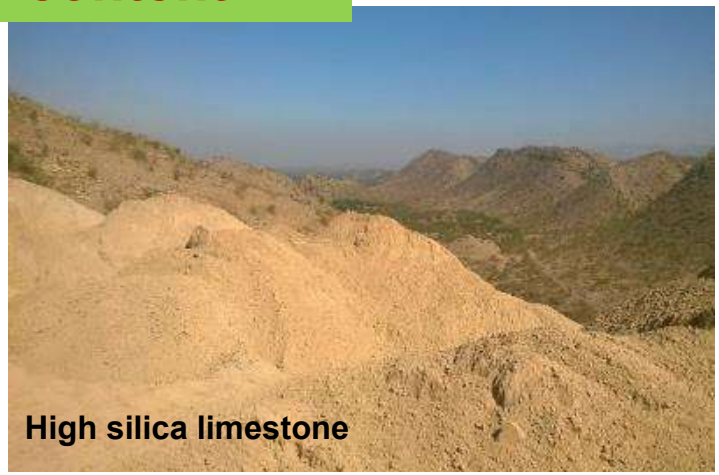
- Saving of upto 60% CO_2 emissions compared to Portland Cement
- Use of renewable fuels to calcine clay at lower temperatures

Raw materials for LC^3?

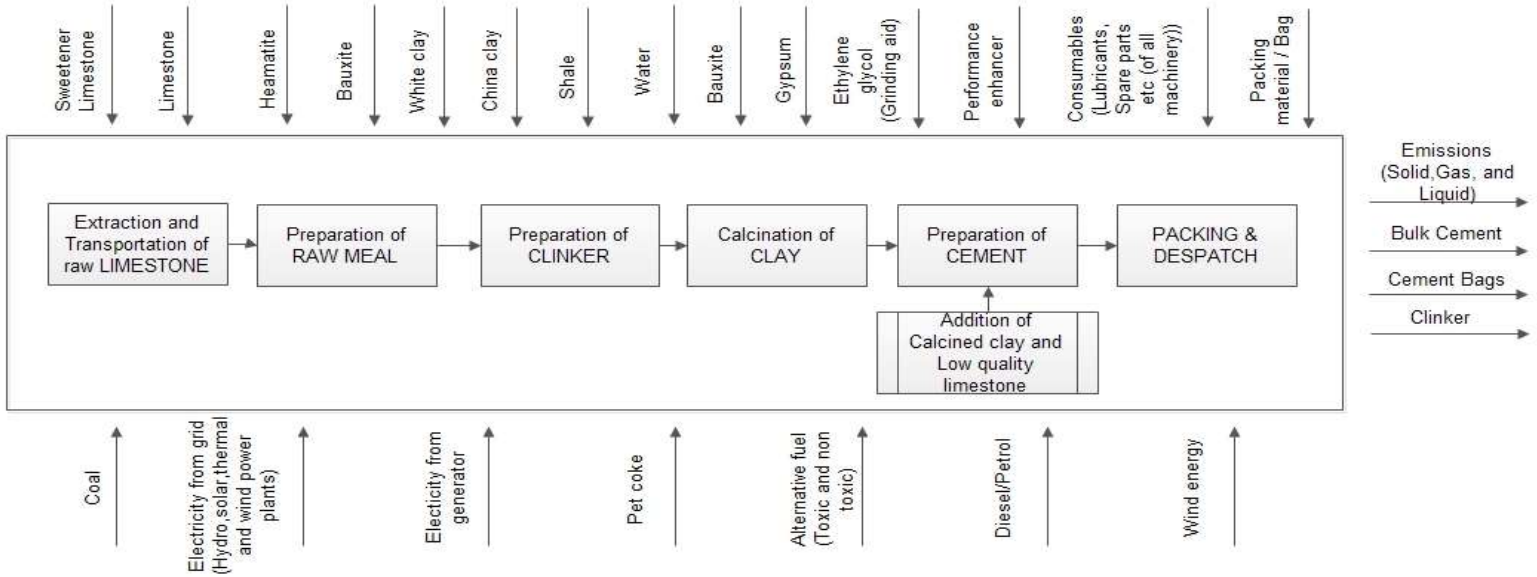
> 40% kaolinite content

Raw materials for LC^3?

> 35% CaO content



Production process of LC^3?

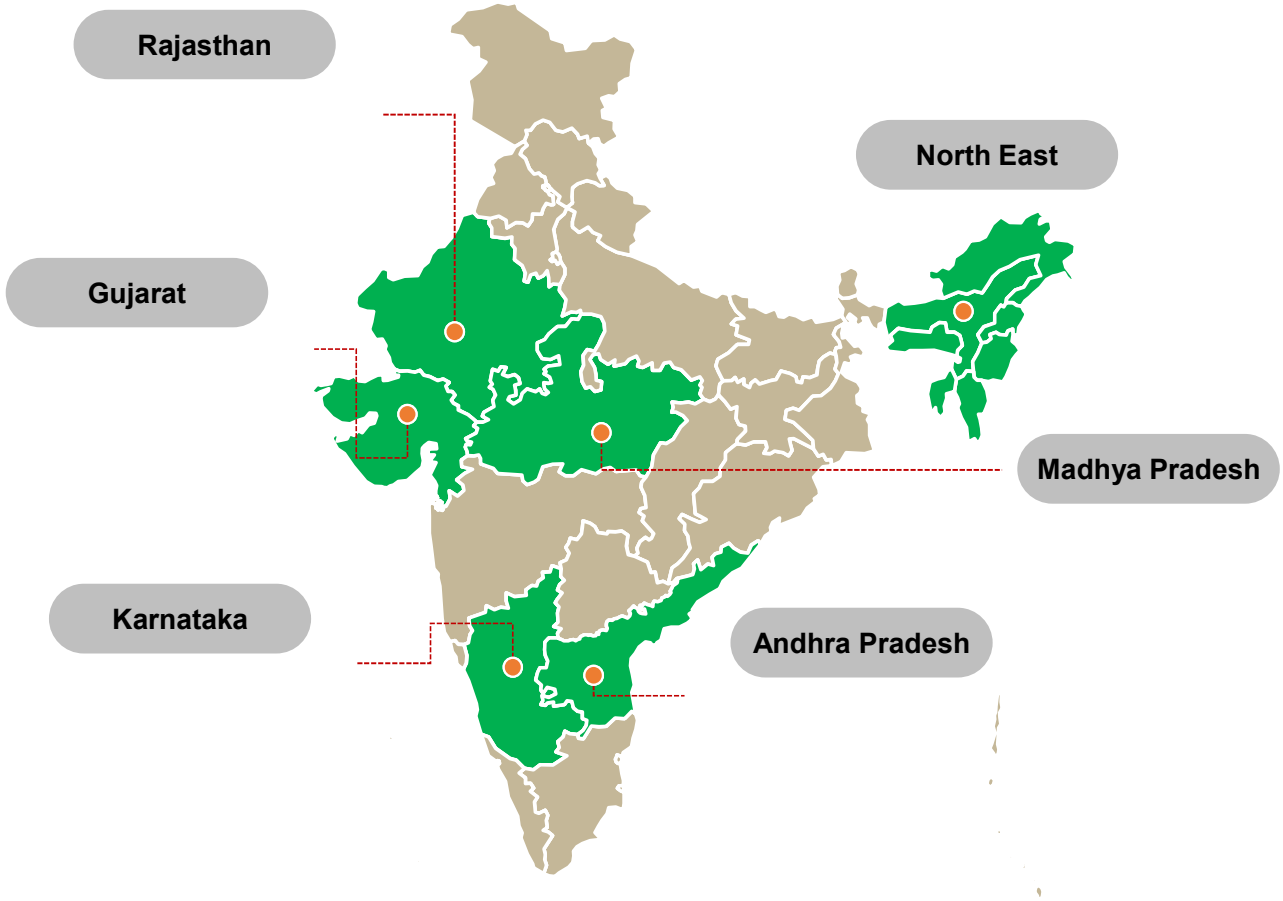


Major raw materials: Limestone, *Kaolinitic clay*, Coal, Pet coke, Lignite
Other significant inputs: Electricity (from the grid), Alternative fuels, Gypsum, White clay, Water, Plant and equipment

Important sub-processes: Limestone extraction, Raw meal preparation, Clinkerization, *Clay calcination*, Blending, Packing and dispatch, Power generation

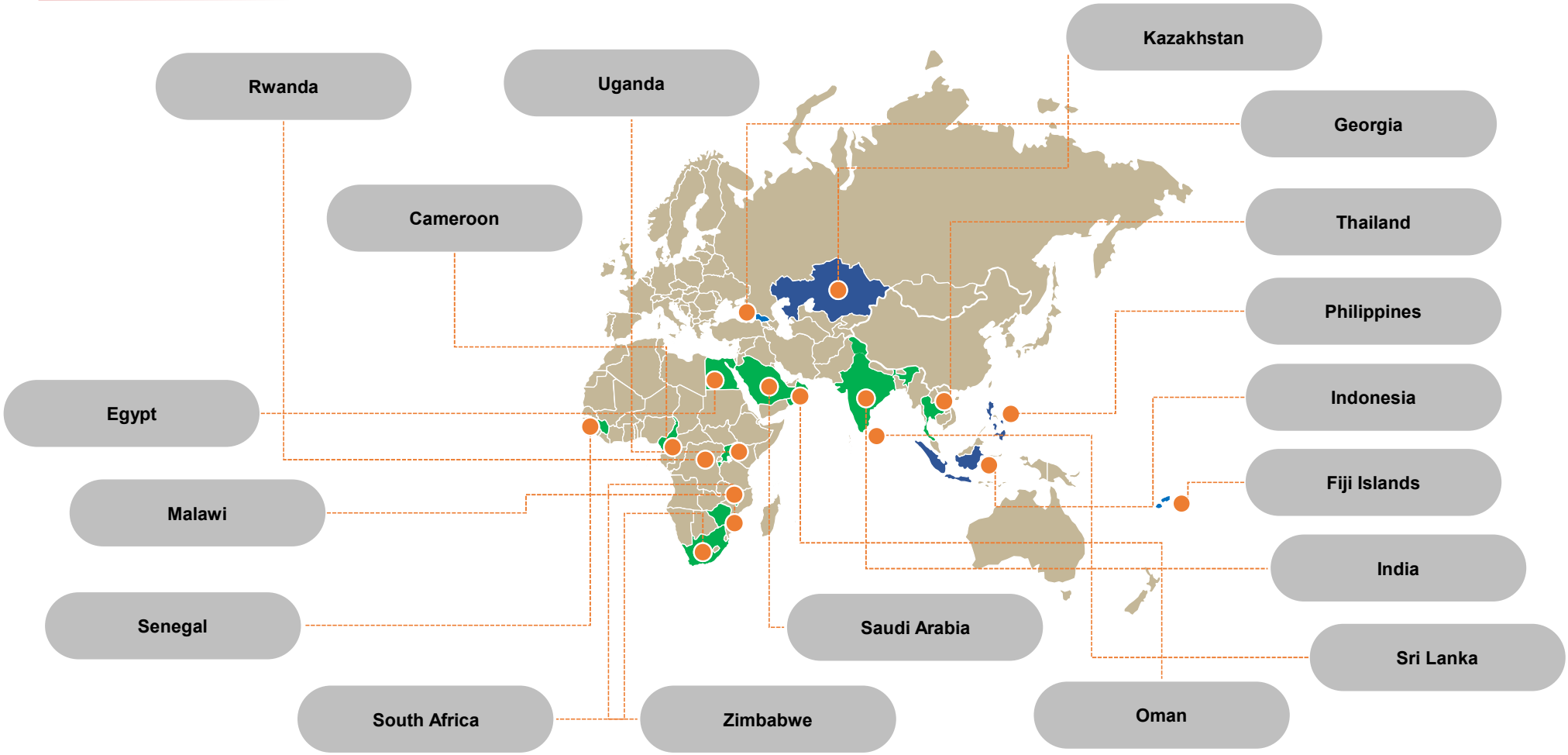
Products: Bulk cement, Cement bags, Clinker

LC^3 in India


Rajasthan
North East
Gujarat
Madhya Pradesh
Karnataka
Andhra Pradesh

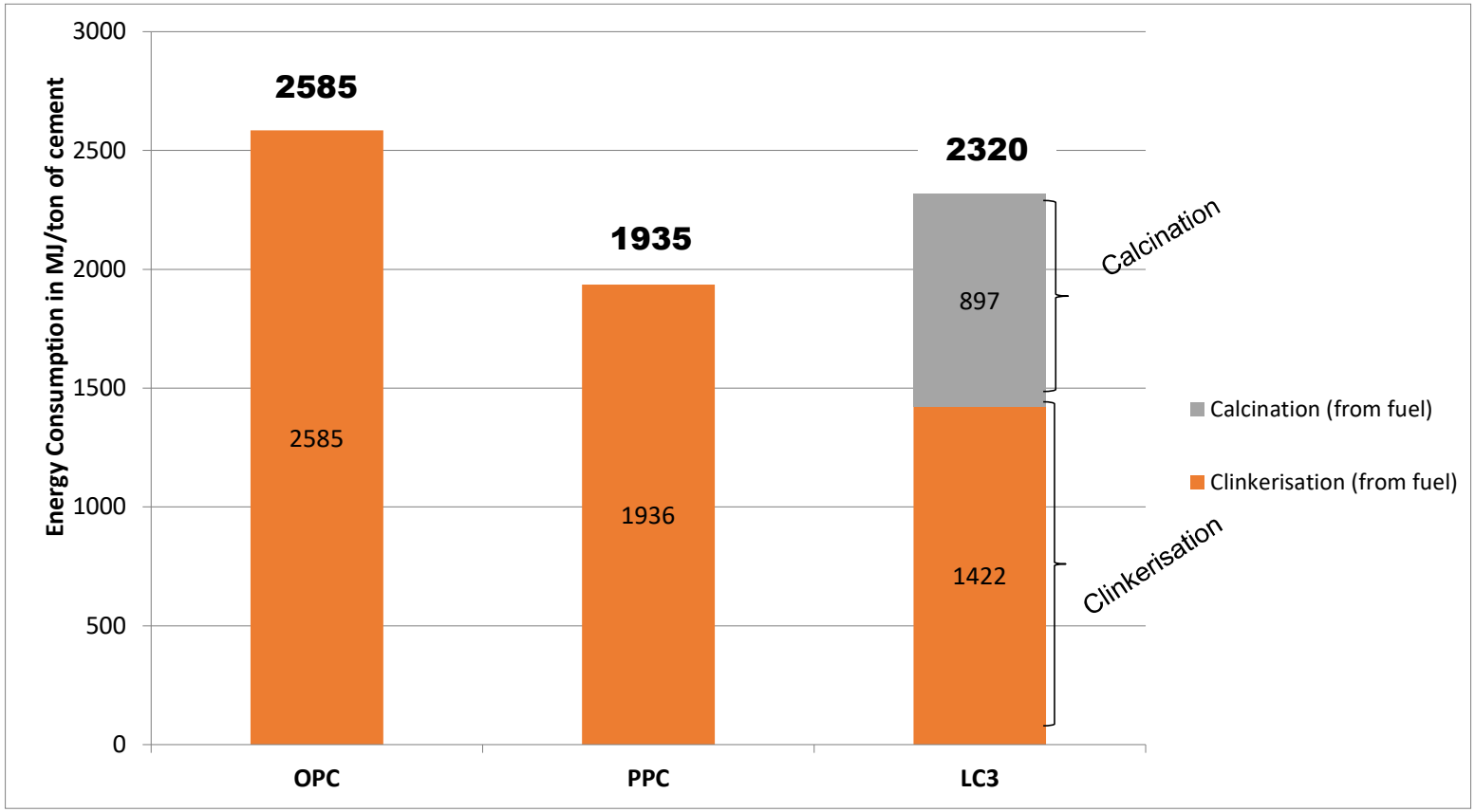

MOU SIGNING CEREMONY
Strategic Partnership for Decarbonisation of Cement

LC^3 in the World



LCA study – Reddipalayam, Ariyalur

Process wise energy consumption – CSI system

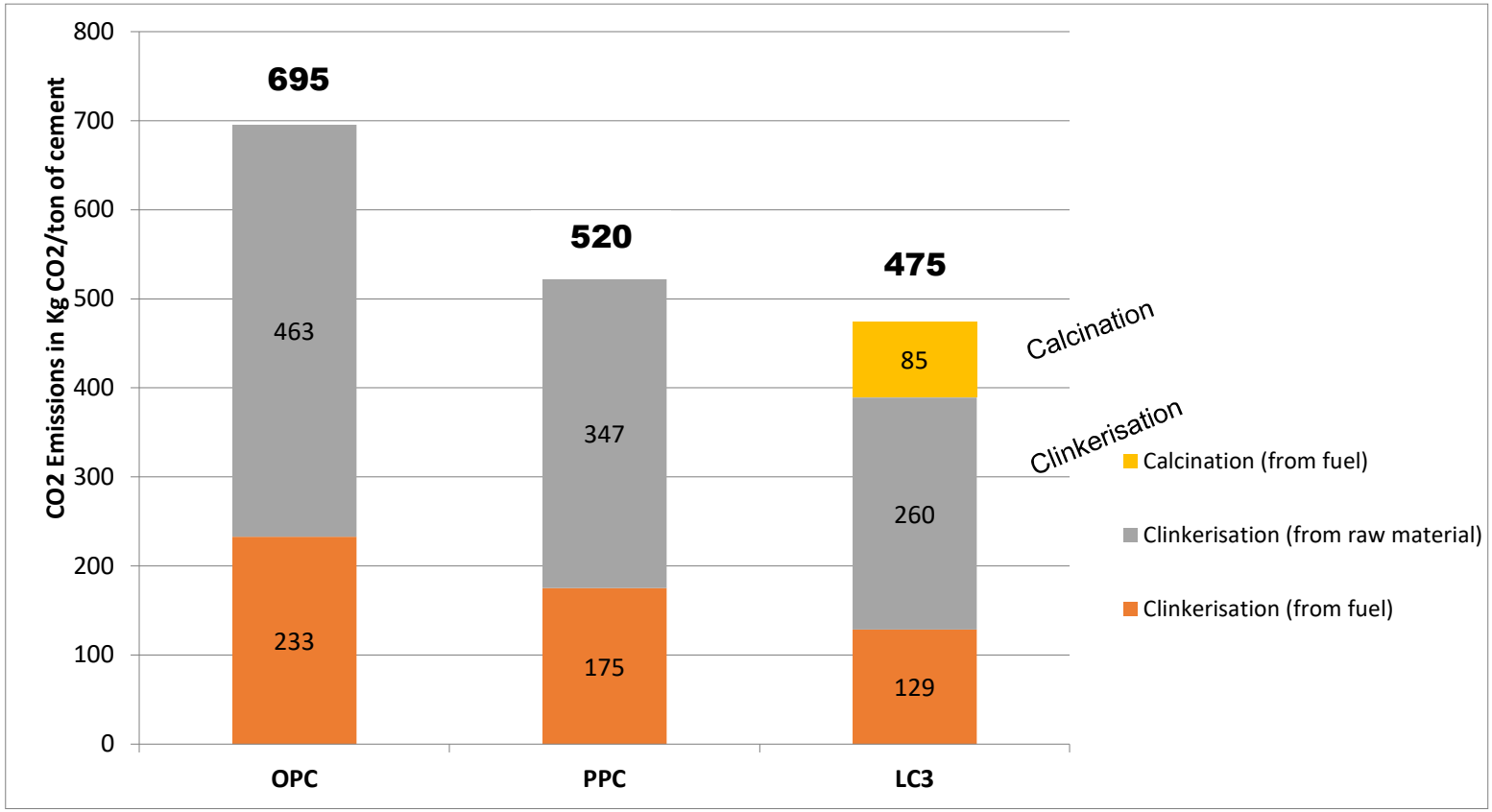


EPFL TARA

Development Alternatives
People | Planet | Prosperity

LCA study – Reddipalayam, Ariyalur

Process wise CO2 emissions – CSI system



The LC³ house at Orchha

CO_2 saved from the use of LC^3

Total CO_2 saved by using LC^3 – 7,720 kg

48 kg of CO_2 saved /m^2

Potentials

- Practically feasible and easy to adopt technology for existing and new cement companies
- To be the preferred choices of cement companies across the world – if china clay is available within a radius of 200 km

Challenges

Technology imperatives

- Continued research on waste materials and concrete in a Mission Mode

Business imperatives

- Carbon credits for LC^3 production
- Green finance for adopting LC^3

Market imperatives

- Visibility of LC^3 with buyers
- Include LC^3 in all national and international rating systems

Policy imperatives

- Fast track publication of LC^3 standards
- Notification on use of LC^3 in public construction and public procurement
- Incentives on use and production of green cement

Acknowledgement

Prof. Karen Scrivener
For her constant guidance, encouragement, and belief that we can do it

Indian Institute of Technology, Delhi
Indian Institute of Technology, Madras
Central University "Marta Abreu" of Las Villas

For constant guidance and support to all partners and the entire programme across the globe

Commercializing the LC^3 technology transfer services across the globe