Strategies for Reducing CO_2 Emissions at Cement Plants

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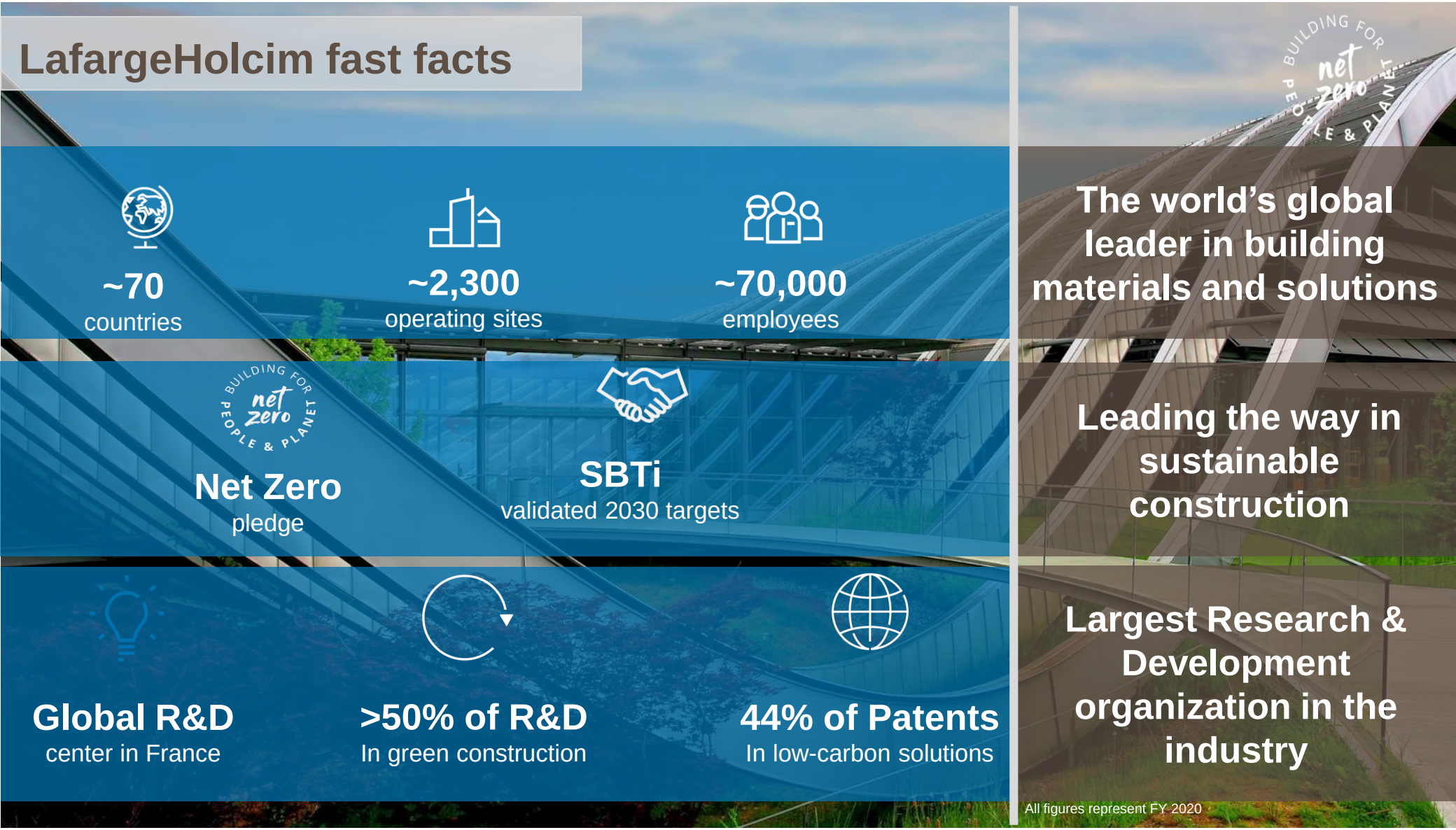
LafargeHolcim fast facts



~70
countries

~2,300
operating sites

~70,000
employees

Net Zero
pledge

SBTi
validated 2030 targets

Global R&D
center in France

>50% of R&D
In green construction

44% of Patents
In low-carbon solutions

The world's global leader in building materials and solutions

Leading the way in sustainable construction

Largest Research & Development organization in the industry

All figures represent FY 2020

Reducing CO_2

Sources of CO_2

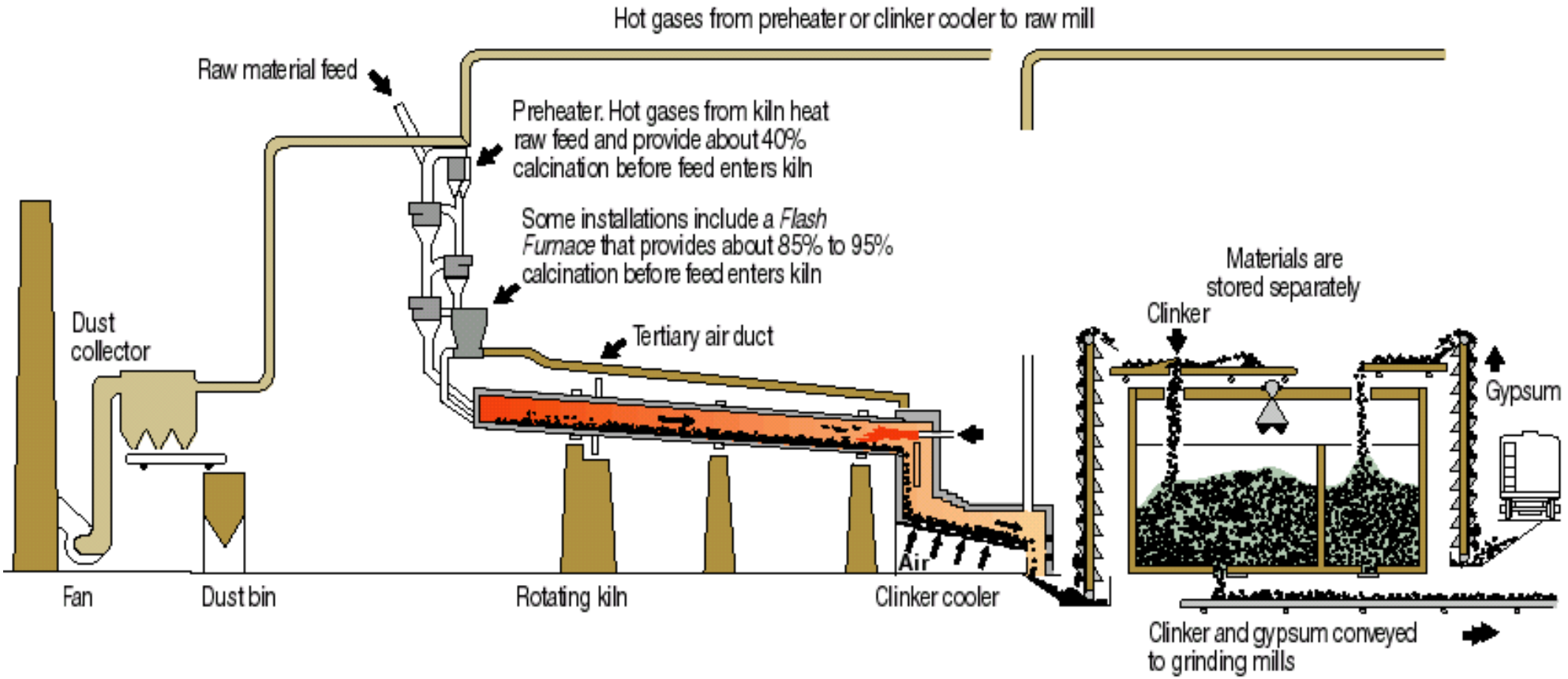
- **Cement industry generates ~ 5% to ~ 8% of all CO_2 generated in the world**

- **Most CO_2 originates from kiln operations:**
  - Fuel for the kiln, normally coal or petcoke
  - Calcination of $CaCO_3$ (limestone)

$$CaCO_3 + heat \Rightarrow CaO + CO_2$$

$$CaO + SiO_2 + heat \Rightarrow C_2S + C_3S \text{ (clinker)}$$

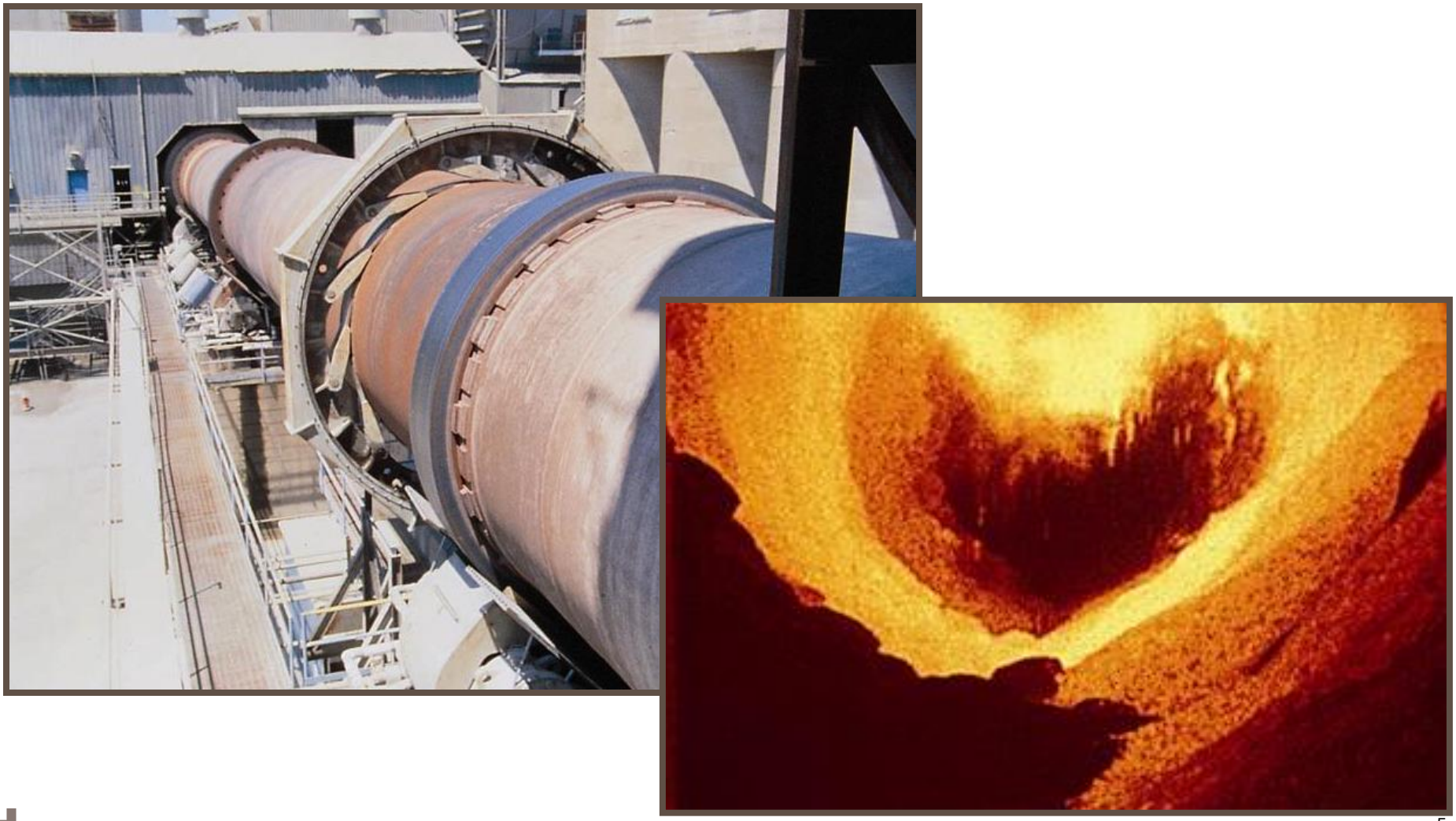
Reducing CO_2



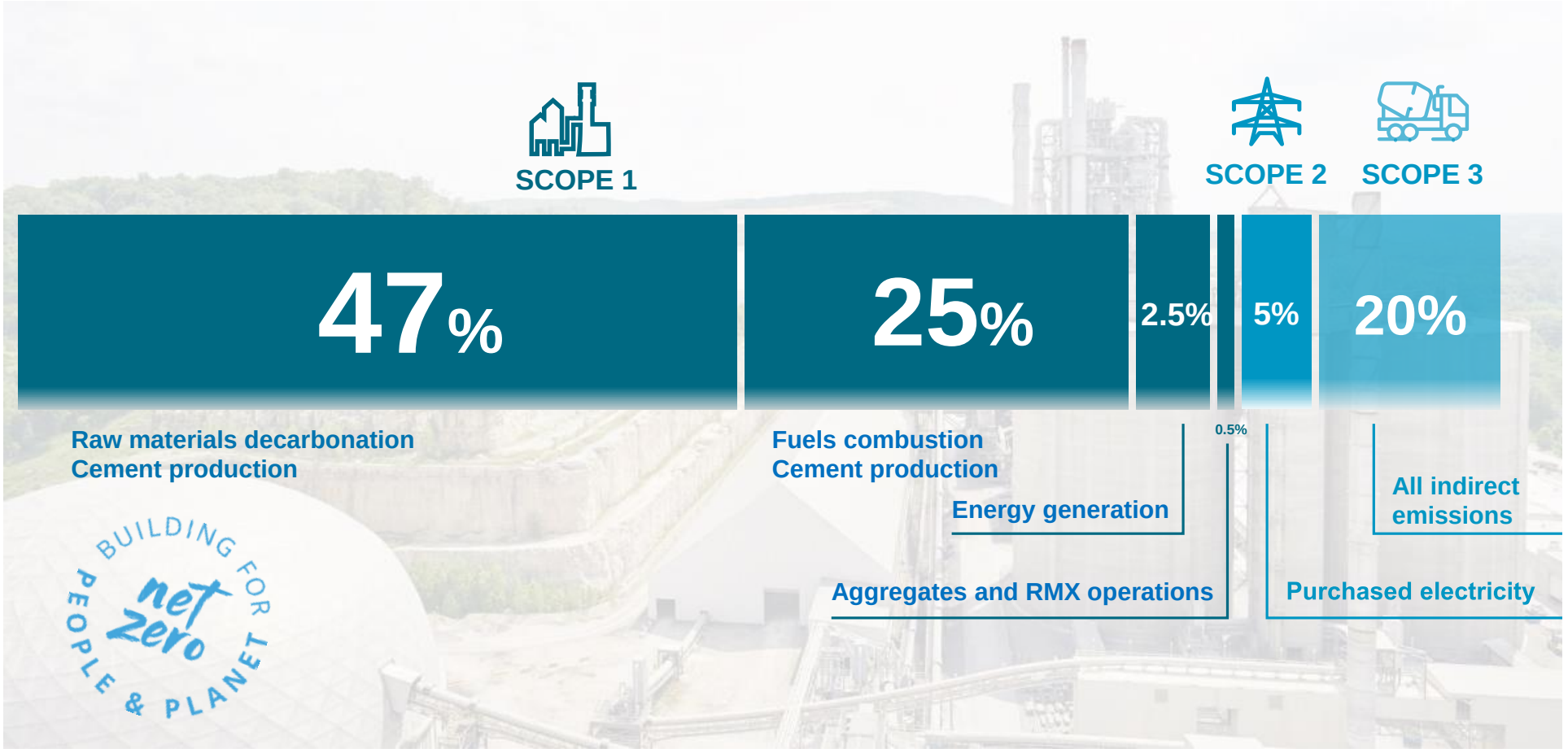
Kiln Operations in a preheater/precalciner plant

Most CO_2 originates from kiln operations

Reducing CO_2



LafargeHolcim CO_2 footprint (company-wide)



LafargeHolcim CO_2 footprint

Definitions of Scopes 1, 2, 3

- **Scope #1**- ~75% of total
  - Raw material decarbonization for cement production
  - Fuel combustion for cement production
  - Generation of electricity
  - Aggregates & RMX operations
- **Scope #2** – ~5% of total
  - Purchased electricity
- **Scope #3** – ~20% of total
  - Extraction of purchased materials
  - Production of purchased materials and fuel
  - Transportation

Reducing CO_2

Measuring CO_2

- PCRs & EPDs
  - Product Category Rules – industry rules that establish how to measure environmental impact
  - Environmental Product Declaration – environmental impact of product as measured by the PCRs
- For cements, Global Warming Potential (GWP) is the main EPD measurement in kg of CO_2 per metric ton of cement
  - U.S. industry average for Type I/II is 922 kg CO_2 / mt
  - U.S. industry average for Type IL is 846 kg CO_2 / mt

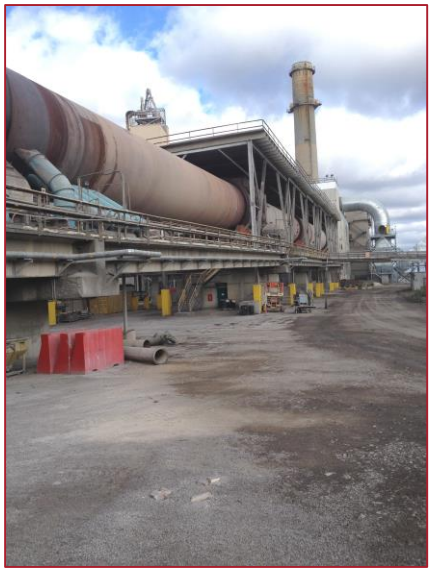
Reducing CO_2

- **Five Main Strategies**
  1. More efficient cement plants
  2. Reduction of purchased electricity
  3. Lower CO_2 fuels and waste derived fuels
  4. Less clinker in cements
  5. Carbon capture utilization & storage (CCUS)

Reducing CO_2

Strategy #1 - More Efficient Plants

- Preheaters / Precalciners vs long, dry or wet kilns
  - GWP of long, dry kiln (no preheater/precalciner) ~ 1000 kg CO_2 / mt
  - GWP of new, preheater/precalciner kiln ~ 750 kg CO_2 / mt



Long, dry kiln

Preheater/precalciner kiln

Reducing CO_2

Strategy #2 - Reduction of purchased electricity

Solar Panels at Hagerstown, MD

Windmills at Paulding, OH

Reducing CO_2

Strategy #3 - Lower CO_2 Fuels & Waste-Derived Fuels

- Use of natural gas vs coal & petcoke in the kilns
  - Natural gas reduces CO_2 by ~40% compared to coal

Ravena Plant in NY uses natural gas as a fuel (summer months only)

Reducing CO_2

Strategy #3 - Lower CO_2 Fuels & Waste-Derived Fuels

- Waste Derived Fuels - use of liquids, plastics, tires, construction waste, etc.
  - Saves CO_2 if material is normally disposed by incineration
  - LEED does not give credit for waste-derived fuels
  - Paulding, OH burns 80% - 90% liquid waste-derived fuels
  - Whitehall, PA burns tires and plastics
  - Holly Hill, SC burns liquid waste-derived fuels

Reducing CO_2

Strategy #4 - Less Clinker in the Cement

- Supplementary Cementitious Materials (SCMs) and ground limestone can be used to replace the clinker portion of a cement
  - ASTM C595 Blended Cements
    - Type IS using slag cement (up to 70%)
    - Type IP using fly ash, silica fume or natural pozzolans (up to 40%)
    - Type IL using ground limestone (up to 15%)
    - Type IT using any 2 of the above

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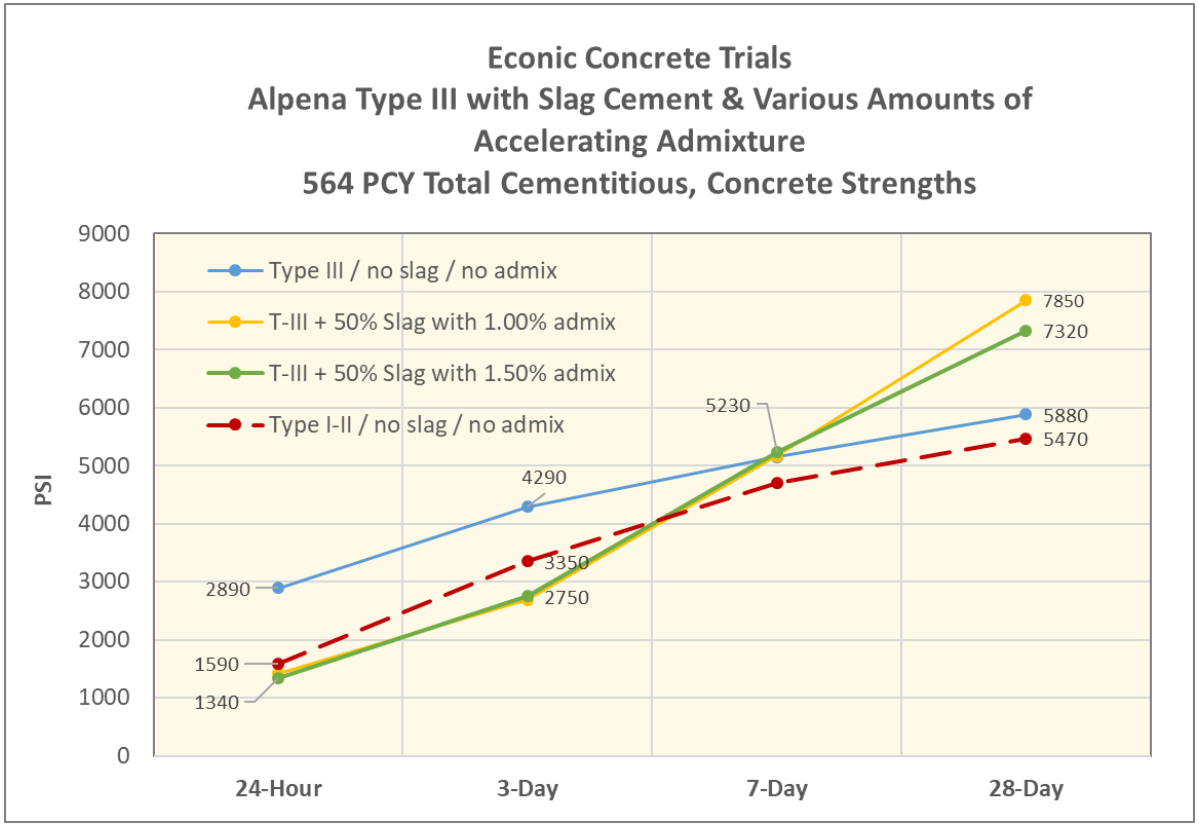
Reducing CO_2

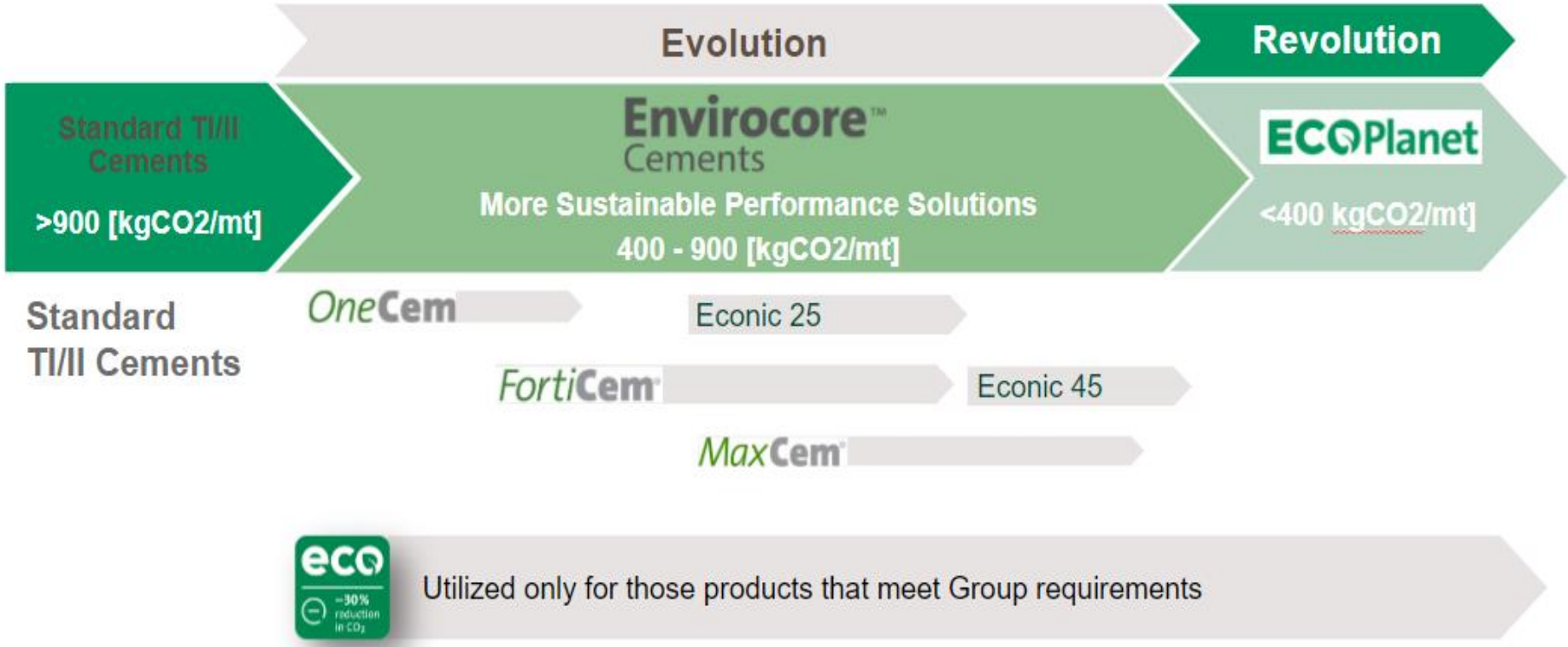
Less Clinker

- Project specifications for cement and concrete need to be more informed & focused on blended cements



EcoPlanet

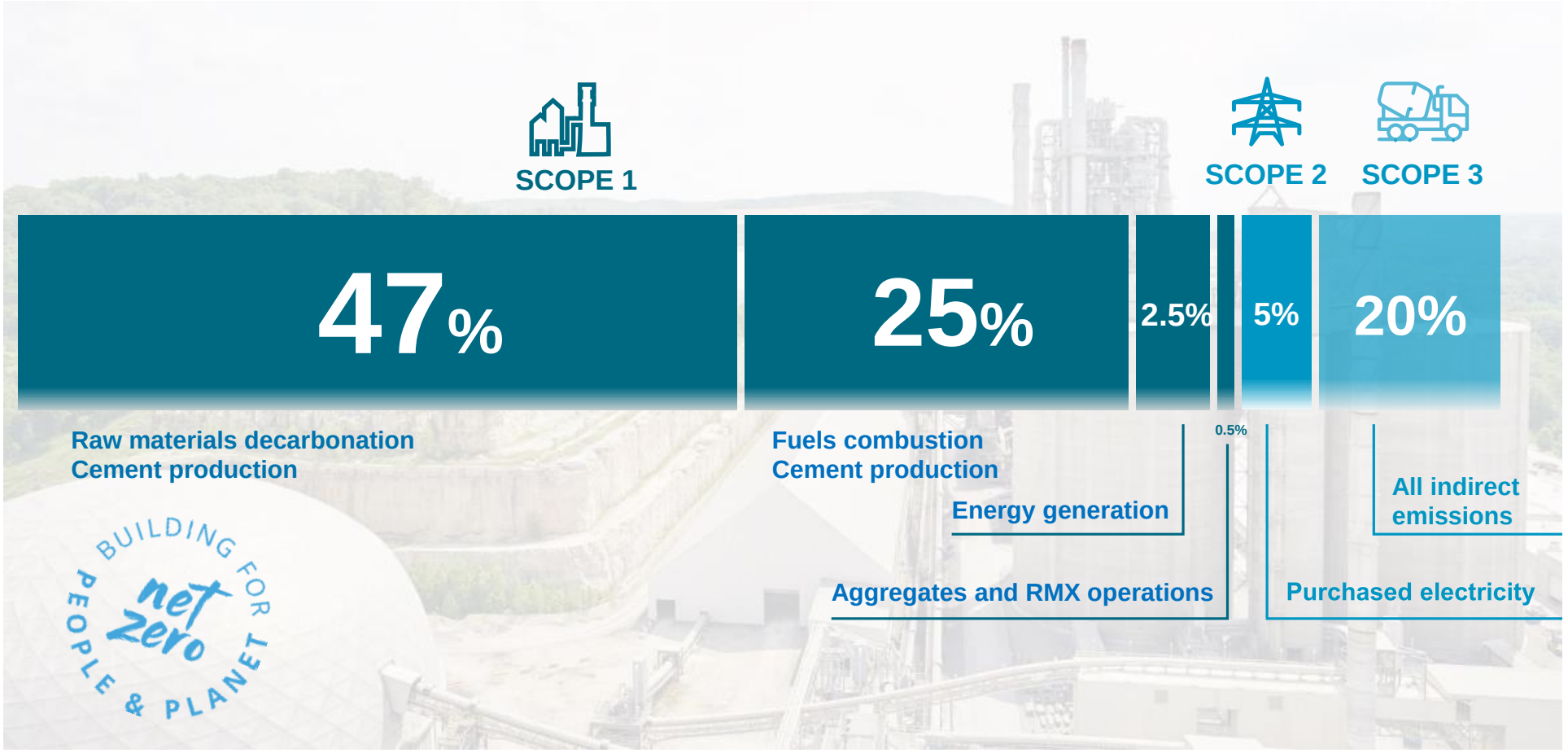
Product Branding



Baseline kgCO2/ton = average US GWP (across US plants as determined by EPDs)

Products meeting the eco label -30 are those that fall 30% below baseline

LafargeHolcim CO_2 footprint (company-wide)

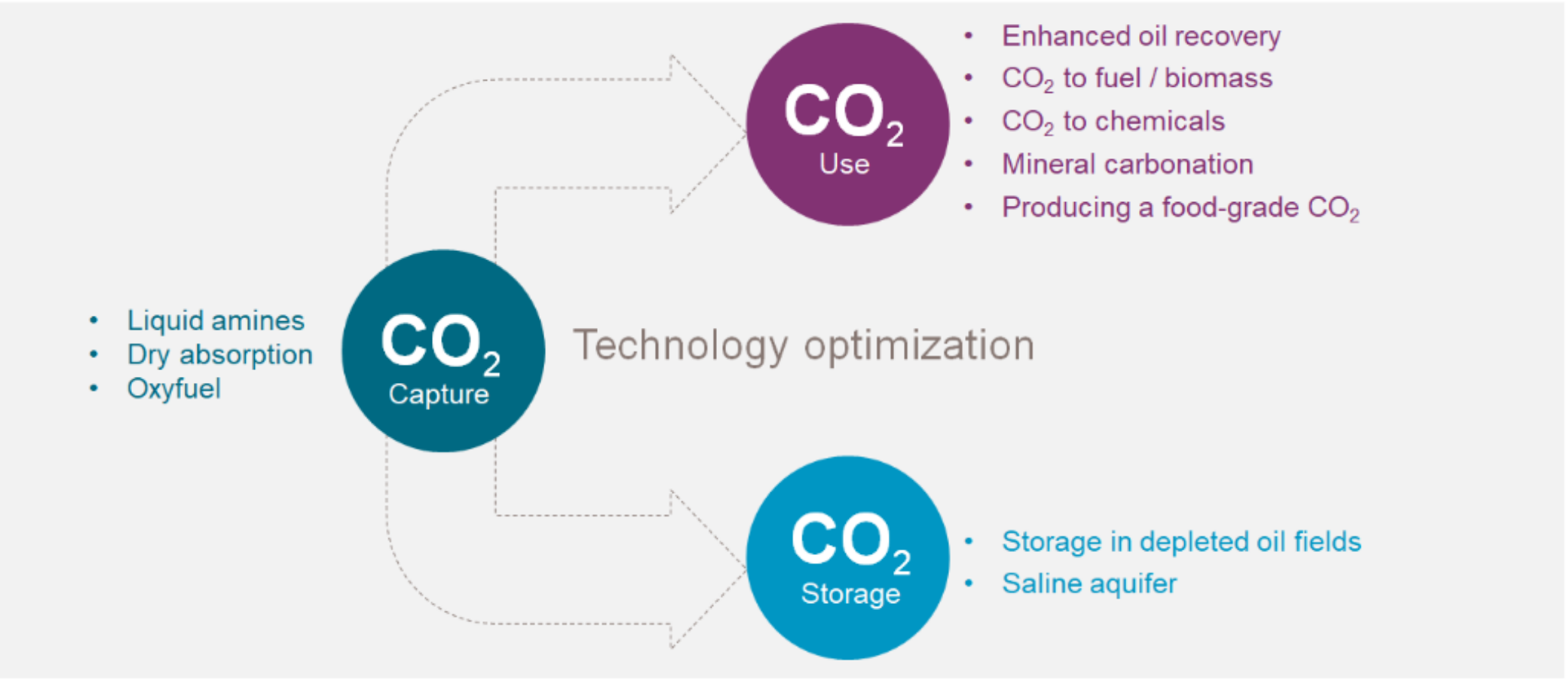


Reducing CO_2

Strategy #5 - Carbon Capture Utilization & Storage (CCUS)

- CCUS captures CO_2 emissions from sources and either reuses or stores it (sequestration) so it doesn't enter the atmosphere
- LH views CCUS as one of the core developing technologies to achieve Net Zero emissions, but is not sizeable or economical to fully implement today
  - LH is currently spearheading over 20 projects in the US, Canada, and Europe

Reducing CO_2



Reducing CO_2

LafargeHolcim worldwide average targets for cement GWP (all products)

- 2022: 550 kg CO_2 /mt
- 2030: 475 kg CO_2 /mt

Reducing CO_2

Questions & Comments?

Reducing CO_2

Estimated Carbon Dioxide Emissions (Statista)

Year	U.S. Emissions in millions of metric tons of CO_2	Average CO_2 Concentrations, NOAA-ESRL Mauna Loa Observatory
2020	4,571(4.57B) mt	419 ppm (May)
2019	5,138	411
2018	5,276	408
2017	5,131	407
2016	5,171	404
2015	5,263	399
2014	5,413	397
2013	5,356	395
2012	5,229	393
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1990	5,040	354
Pre-industrial		278

Reducing CO_2

- Total Estimated Annual CO2 Emissions by Country - Union of Concerned Scientists (based on 2018 data)

1.	China	10.06 GT	~30%
2.	U.S.	5.41 GT	~15%
3.	India	2.65 GT	~ 6%
4.	Russian Federation	1.71 GT	
5.	Japan	1.16 GT	
6.	Germany	0.75 GT	
7.	Iran	0.72 GT	
8.	South Korea	0.65 GT	

Reducing CO_2

- A research team, led by the U.S. Department of Energy's (DOE) Argonne National Laboratory in collaboration with Northern Illinois University, has discovered a new electrocatalyst that converts carbon dioxide (CO_2) and water into ethanol
  - very high energy efficiency
  - high selectivity for the desired final product
  - low cost.
- Ethanol is a particularly desirable commodity because it is an ingredient in nearly all U.S. gasoline and is widely used as an intermediate product in the chemical, pharmaceutical and cosmetics industries.

Reducing CO_2

- Carbon-neutral fuels are synthetic hydrocarbons. They can be produced in chemical reactions between carbon dioxide, which can be captured from power plants or the air, and hydrogen, which is created by the electrolysis of water using renewable energy.

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