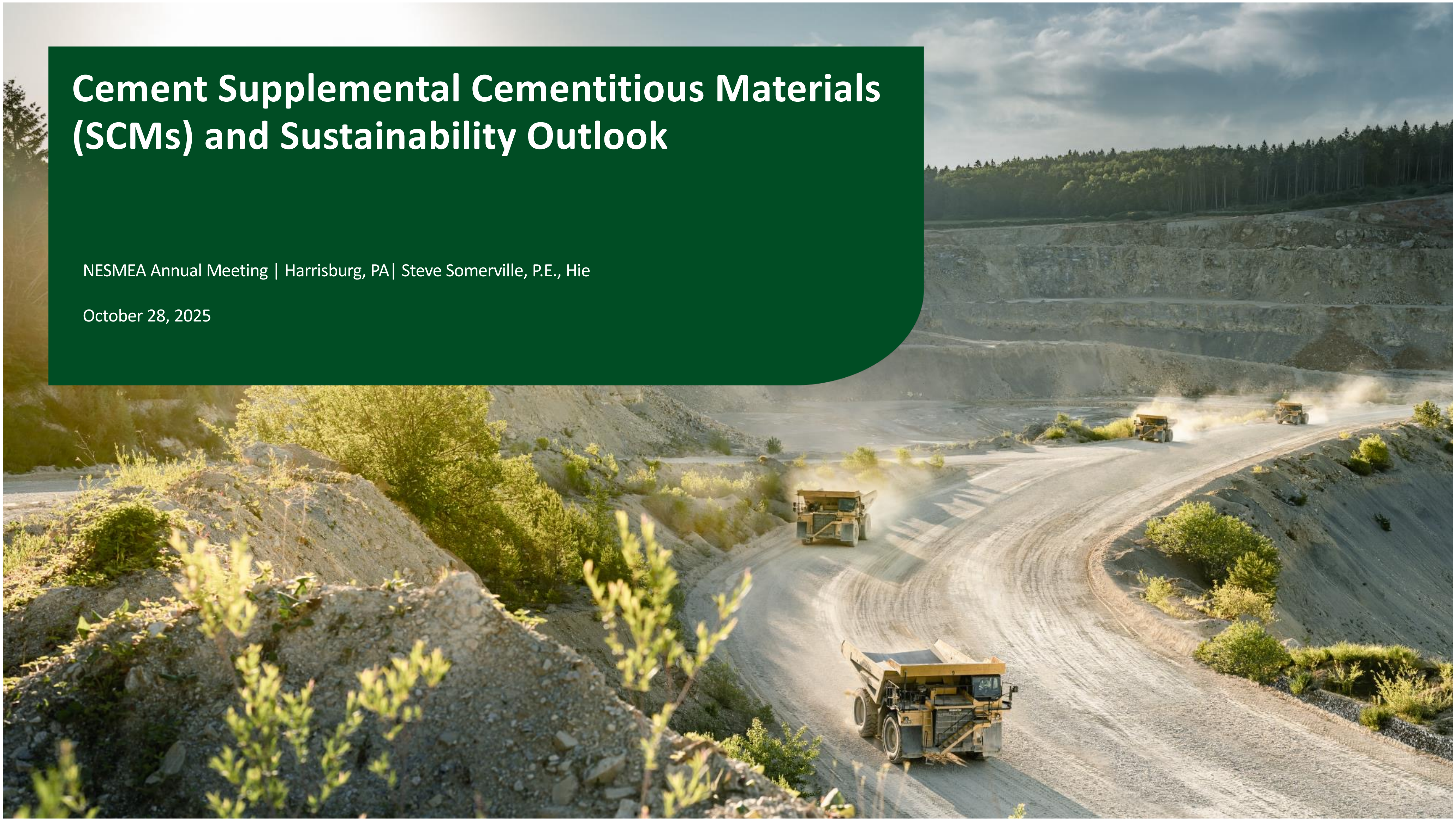
Cement Supplemental Cementitious Materials (SCMs) and Sustainability Outlook

NESMEA Annual Meeting | Harrisburg, PA| Steve Somerville, P.E., Hie

October 28, 2025



Agenda

Background

- Usage & Emissions
- Policy

Present Strategies

- Blended Cements
- Mix Optimization

Future Outlook

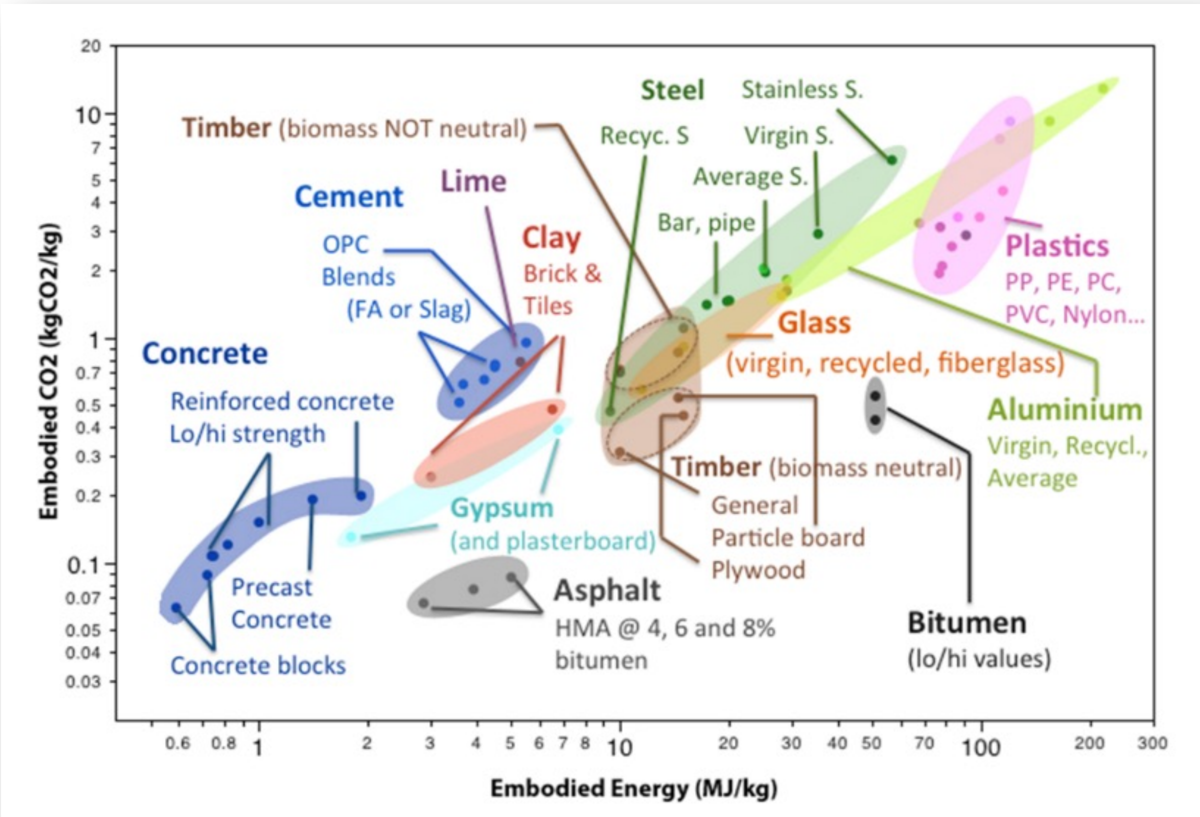
- More/New SCMs
- CCUS

Concrete Accounts for More Than 50% of Everything We Make[1]

Most widely produced solid material on earth

- Concrete delivers…
  - Economy
  - Strength & Durability
  - Versatility
  - Resilience
- Because concrete is practically synonymous with the term construction it….
  - Is responsible for 7% – 8% of global manmade CO_2 emissions
  - Can be argued that this is a relatively small CO_2 investment for more than 50% of the stuff we make but, we are working to lower these numbers

[1]Rencontre du Conseil d'Etat avec la Présidence de l'EFL EPFL Fribourg, https://www.concrete.org/portals/0/files/pdf/webinars/ws_S23_KarenScrivener.pdf

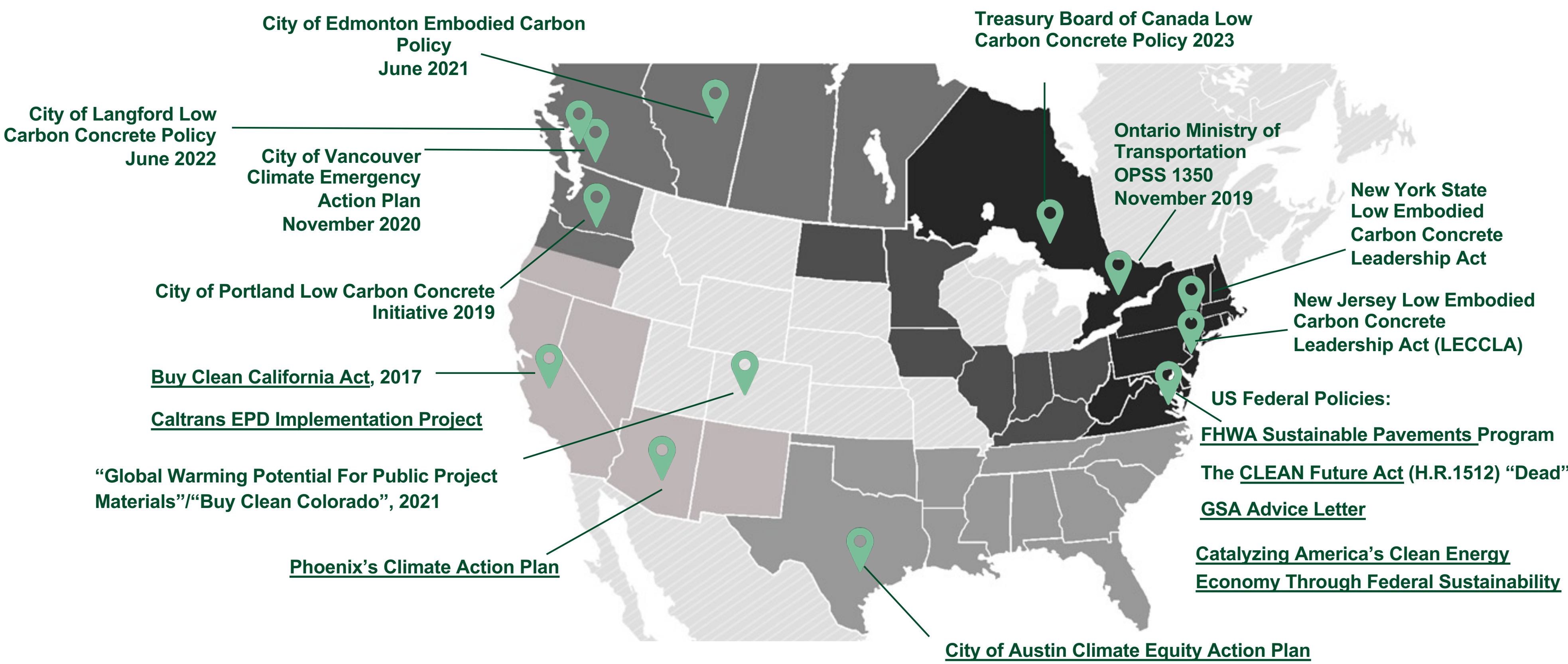


Global CO_2 Emissions

Cement is a very sustainable material with relatively low environmental impacts.

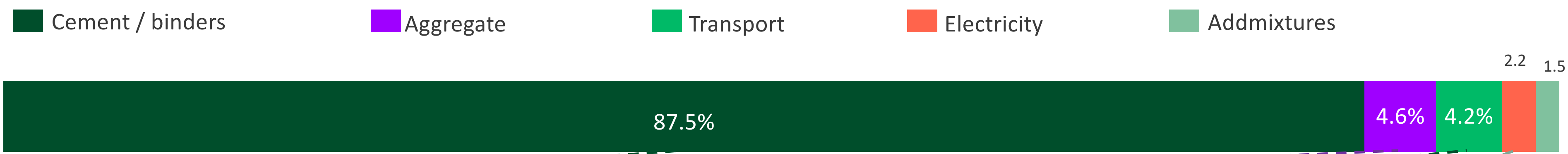
Concrete is **the** global sustainable building material of choice; its CO_2 impacts are the very low.

Embodied Carbon Policies Developing Across North America



https://carbonleadershipforum.org/clf-policy-toolkit/#policymap

CO_2 during concrete production



- Process technology in cement
- Alternative binding agents, SCMs

- Local, low energy and low GWP building materials
- An uncounted CO_2 success factor

- Efficient logistics
- Utilising state-of-the-art drive units
- Openness for new technologies

- Renewable energy is a usable benefit today

CO_2 in concrete is more than just cement

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Present Strategies to Decarbonize Concrete

Reduce the clinker in cement and concrete

- Produce and use more SCMs to reduce CO_2 and optimize mixes
- Convert to producing Portland Limestone Cements (PLCs)
- Produce more Blended Cements i.e. Type IS(40)

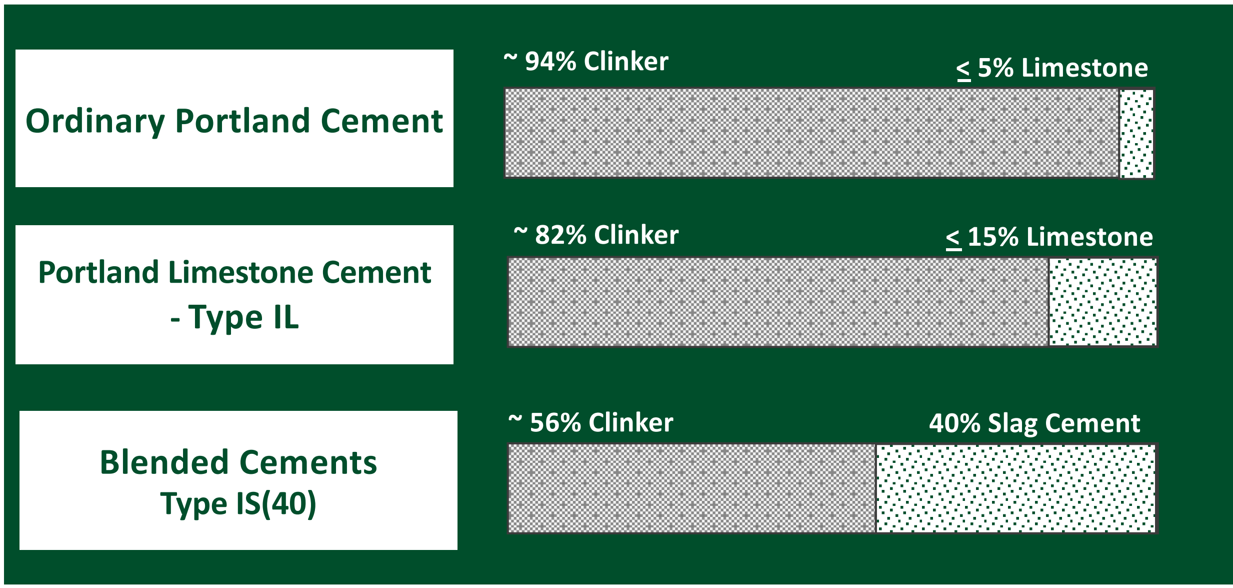
Reduce the CO_2 in clinker

- Increase energy efficiency in production
- Utilize natural gas and Alternative Fuels
- [illegible]

Educate users and stakeholders to reduce overdesign

- Utilize real time mix and maturity monitoring
- Optimize concrete mixes/element shapes and right sized design

Clinker Factor in Cements



Portland Limestone Cement: Type IL

Widespread roll-out of Type IL in North America began in 2021

Accepted by all 50 state DOTs and most Canadian provinces

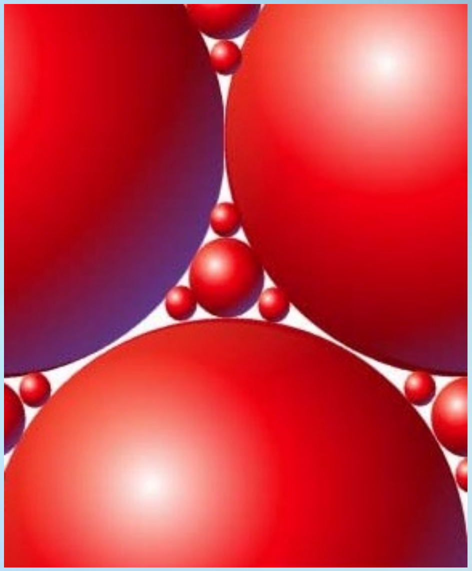
Over 70% of cement produced in USA is Type IL

Type IL is permitted:

- By codes, like ACI 318, Building Code Requirements for Structural Concrete
- By specifications, like ACI 301, Specification for Structural Concrete
- By standards, like ASTM C94, Specification for Ready Mixed Concrete
- And by the AIA MasterSpec that is used by design firms to develop their specifications for private projects.

How Limestone Works

- Particle packing
  - Improved particle size distribution
- Nucleation
  - Surfaces for precipitation
- Chemical reactions
  - Only a small amount, but...



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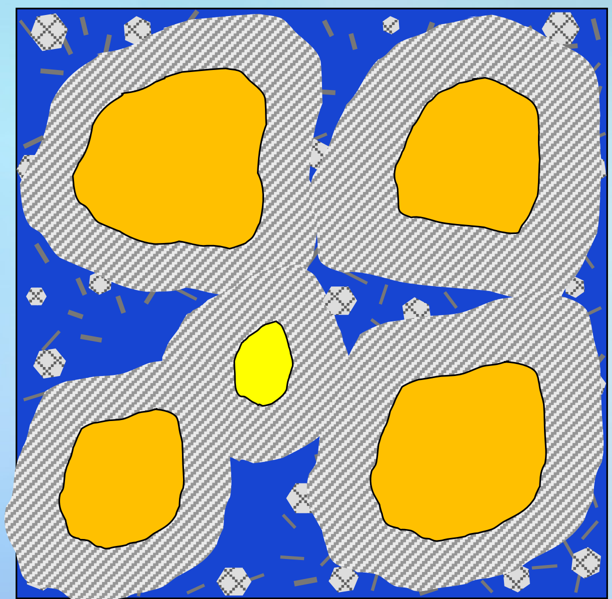

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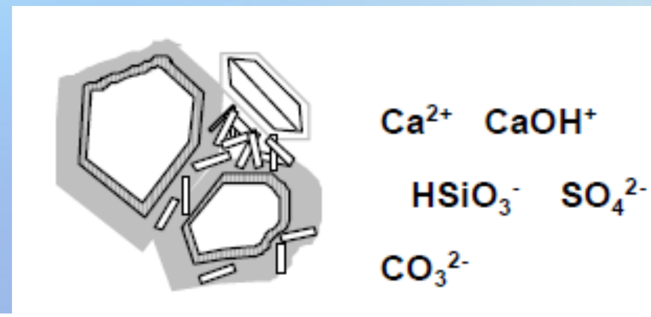
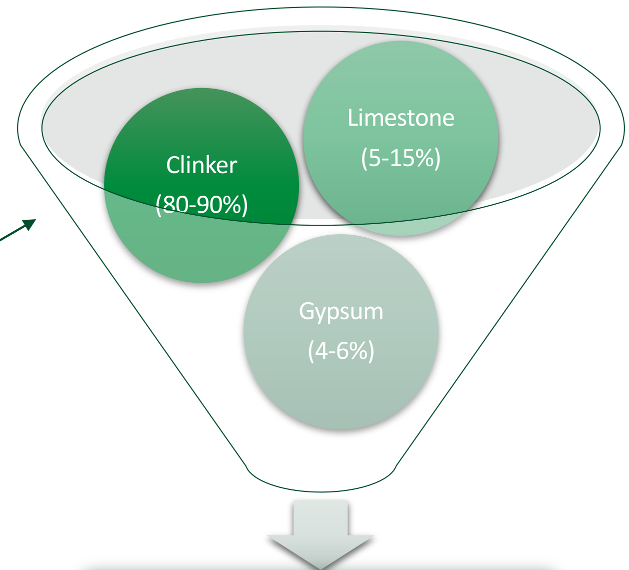


Portland Limestone Cement: Type IL

Material	ASTM C150 AASHTO M85 Portland Cement	ASTM C595 AASHTO M240 PLC
Clinker (typical)	90 to 95 %	80 to 90 %
Gypsum (typical)	4 to 6 %	4 to 6 %
Limestone	0 to 5 %	5 to 15 %



ECOCEM PLC™

Cement Replacements - An Important Part of Today's Mixes

Supplementary Cementitious Materials (SCMs)

- Defined by ACI Concrete Terminology ACI CT-23
  - "Supplementary cementitious material - inorganic material such as fly ash, silica fume, metakaolin, or slag cement that reacts pozzolanically or hydraulically"
- Combined in concrete mixes in conjunction with and to replace some of the Portland Cement binder
- SCMs have lower Global Warming Potentials (GWP) than Portland cement-based binders
- GWP (kg CO_2 equivalent aka CO_2 eq.)

Portland Slag Cement Delivers Significant CO_2 Reductions

Compare industry average vs. high performing plant in Generic Mix

- Industry Average Portland Cement Type I / GU @ 922 GWP

Calculation for PCA "Average" Portland Cement GWP in Concrete Mix A1			
Generic Concrete Mix Raw Materials A1	Quantity kg/m^3	GWP / Metric ton (1,000 kg)	GWP in Mix
Industry Average Portland Cement (GU / Type I)	350	922	322.7

- Compared to actual EPD Data →
- Heidelberg Materials Evansville Plant
  - Preheater/Precalciner
  - Produces IS(40) Cement
- Portland Cement Type I @ 841 GWP
- Portland Slag IS(40) @ 531 GWP

Environmental Impacts

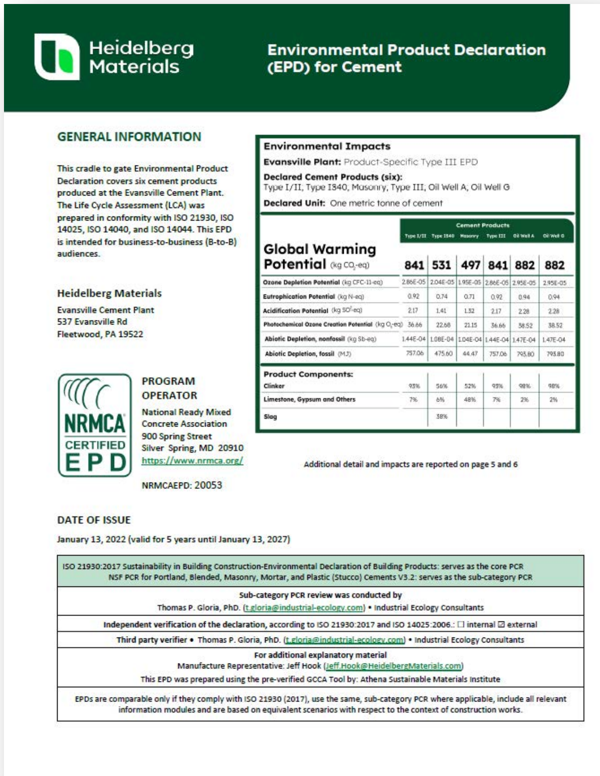
Evansville Plant: Product-Specific Type III EPD

Declared Cement Products (six):
Type I/II; Type IS40; Masonry; Type III; Oil Well A; Oil Well G

Declared Unit: One metric tonne of cement

	Cement Products					
	Type I/II	Type IS40	Masonry	Type III	Oil Well A	Oil Well G
Global Warming Potential (kg CO_2-eq)	841	531	497	841	882	882
Ozone Depletion Potential (kg CFC-11-eq)	2.86E-05	2.04E-05	1.95E-05	2.86E-05	2.95E-05	2.95E-05
Eutrophication Potential (kg N-eq)	0.92	0.74	0.71	0.92	0.94	0.94
Acidification Potential (kg SO^2-eq)	2.17	1.41	1.32	2.17	2.28	2.28
Photochemical Ozone Creation Potential (kg O_3-eq)	36.66	22.68	21.15	36.66	38.52	38.52
Abiotic Depletion, nonfossil (kg Sb-eq)	1.44E-04	1.08E-04	1.04E-04	1.44E-04	1.47E-04	1.47E-04
Abiotic Depletion, fossil (MJ)	757.06	475.60	44.47	757.06	793.80	793.80
Product Components:						
Clinker	93%	56%	52%	93%	98%	98%
Limestone, Gypsum and Others	7%	6%	48%	7%	2%	2%
Slag		38%				

EPD Data Shows Portland Slag Cement Delivers Significant CO_2 Reductions


Heidelberg Materials

Environmental Product Declaration (EPD) for Cement

GENERAL INFORMATION

This cradle to gate Environmental Product Declaration covers six cement products produced at the Evansville Cement Plant. The Life Cycle Assessment (LCA) was prepared in conformity with ISO 21930, ISO 14025, ISO 14040, and ISO 14044. This EPD is intended for business-to-business (B-to-B) audiences.

Heidelberg Materials

Evansville Cement Plant
537 Evansville Rd
Fleetwood, PA 19522

PROGRAM OPERATOR

National Ready Mixed Concrete Association
900 Spring Street
Silver Spring, MD 20910
https://www.nrmca.org/

NRMCAEPD: 20053

Environmental Impacts

Evansville Plant: Product-Specific Type III EPD

Declared Cement Products (six): Type I/II, Type IS40, Masonry, Type III, Oil Well A, Oil Well G

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Additional detail and impacts are reported on page 5 and 6

DATE OF ISSUE

January 13, 2022 (valid for 5 years until January 13, 2027)

ISO 21930:2017 Sustainability in Building Construction-Environmental Declaration of Building Products: serves as the core PCR
NSF PCR for Portland, Blended, Masonry, Mortar, and Plastic (Stucco) Cements V3.2: serves as the sub-category PCR

Sub-category PCR review was conducted by
Thomas P. Gloria, PhD. (t.gloria@industrial-ecology.com) • Industrial Ecology Consultants

Independent verification of the declaration, according to ISO 21930:2017 and ISO 14025:2006.: ☐ internal ☑ external

Third party verifier • Thomas P. Gloria, PhD. (t.gloria@industrial-ecology.com) • Industrial Ecology Consultants

For additional explanatory material
Manufacture Representative: Jeff Hook (Jeff.Hook@HeidelbergMaterials.com)
This EPD was prepared using the pre-verified GCCA Tool by: Athena Sustainable Materials Institute

EPDs are comparable only if they comply with ISO 21930 (2017), use the same, sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

Compare industry average vs. high performing plant

Industry Average Portland Cement (Type I/II) @ 922 GWP

Calculation for PCA "Average" Portland Cement GWP in Concrete Mix A1			
Generic Concrete Mix Raw Materials A1	**Quantity kg/m^3**	**GWP / Metric ton (1,000 kg)**	**GWP in Mix**
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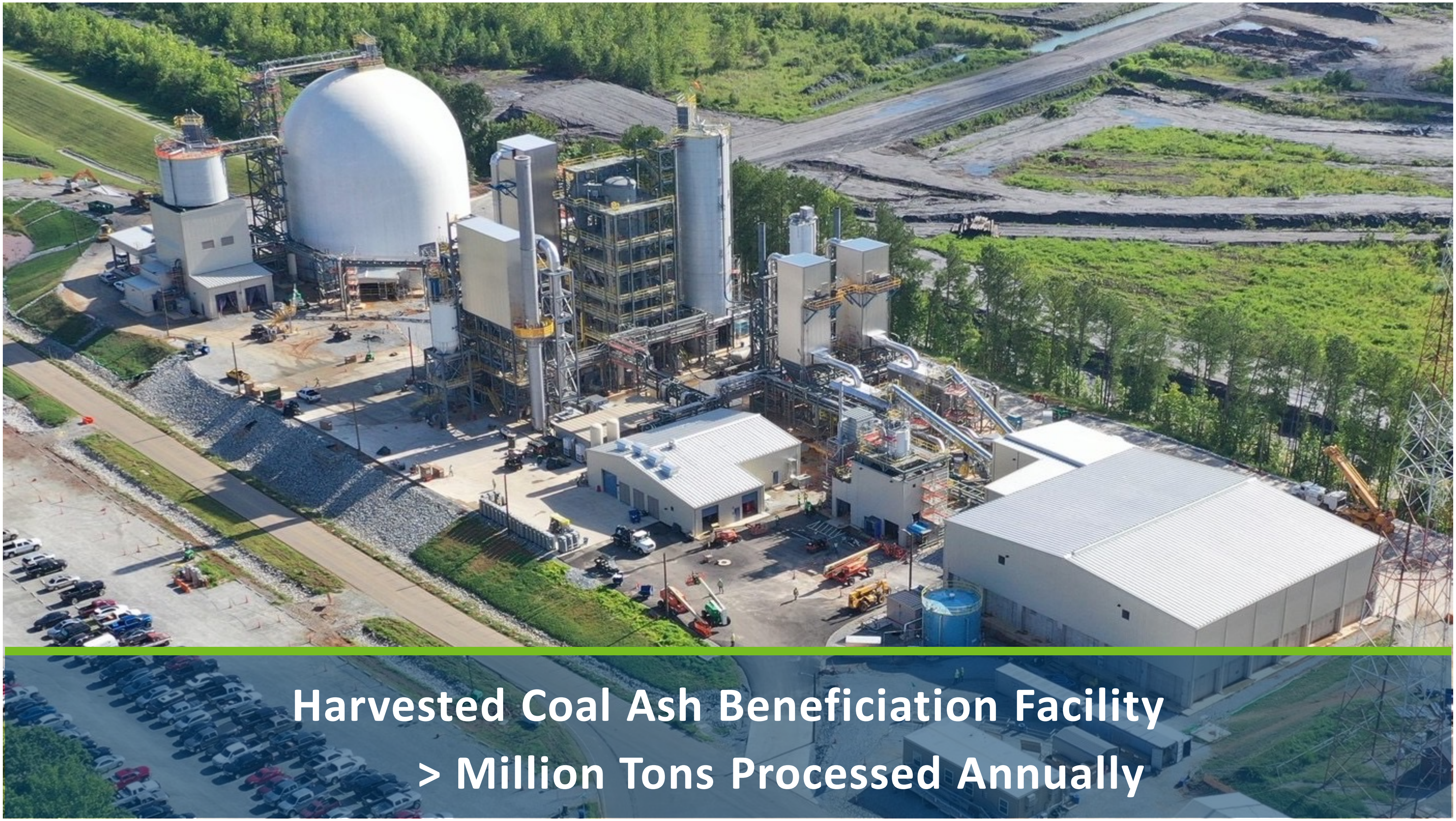
- Heidelberg Materials Evansville Plant Portland Cement (Type I/II)

Calculation for Evansville Portland Cement GU (Type I/III) GWP in Concrete Mix A1			
Generic Concrete Mix Raw Materials + Actual Cement GWP Values A1	**Quantity kg/m^3**	**GWP / Metric ton (1,000 kg)**	**GWP in Mix**
Heidelberg Materials Evansville Type I/III Cement	350	841	294.4

- Heidelberg Materials Evansville Portland Slag Cement Type IS(40)

Calculation for Evansville Portland Slag Cement (Type IS(40)) GWP in Concrete Mix A1			
Generic Concrete Mix Raw Materials + Actual Cement GWP Values A1	**Quantity kg/m^3**	**GWP / Metric ton (1,000 kg)**	**GWP in Mix**
Heidelberg Materials Evansville Type IS(40) Cement	350	531	185.9


Harvested Coal Ash Beneficiation Facility
> Million Tons Processed Annually

Adapting Our Business to Build a Net Zero Future with Beneficiated Ash

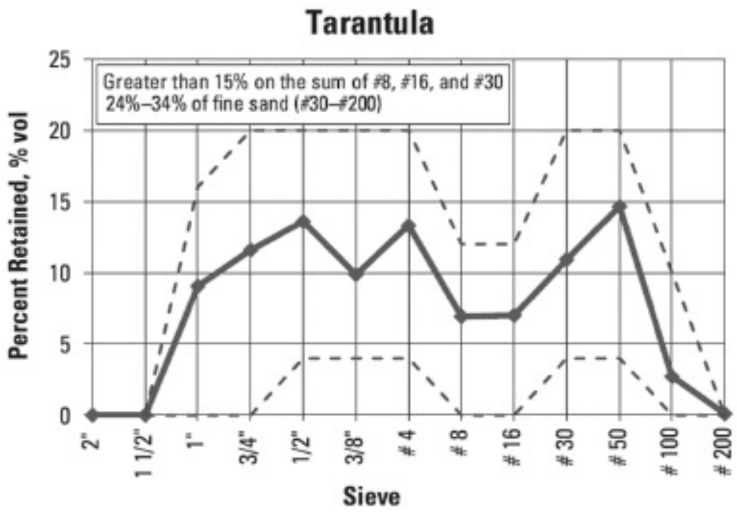
Fly Ash is low GWP replacement for concrete

Securing fly ash supply to further reduce our CO2 footprint

- Heidelberg is the leader in Beneficiated Ash
- Acquired SEFA Group in 2023 secures largest recycled fly ash sources in USA
- This strengthens our ability to provide low-carbon cementitious products in key markets
- Beneficiated ash is hugely important SCM
- > 1-Million tons beneficiated ash sold in 2023
- > Billion tons of available as landfilled ash
- Estimates of having at least 60-year of supply

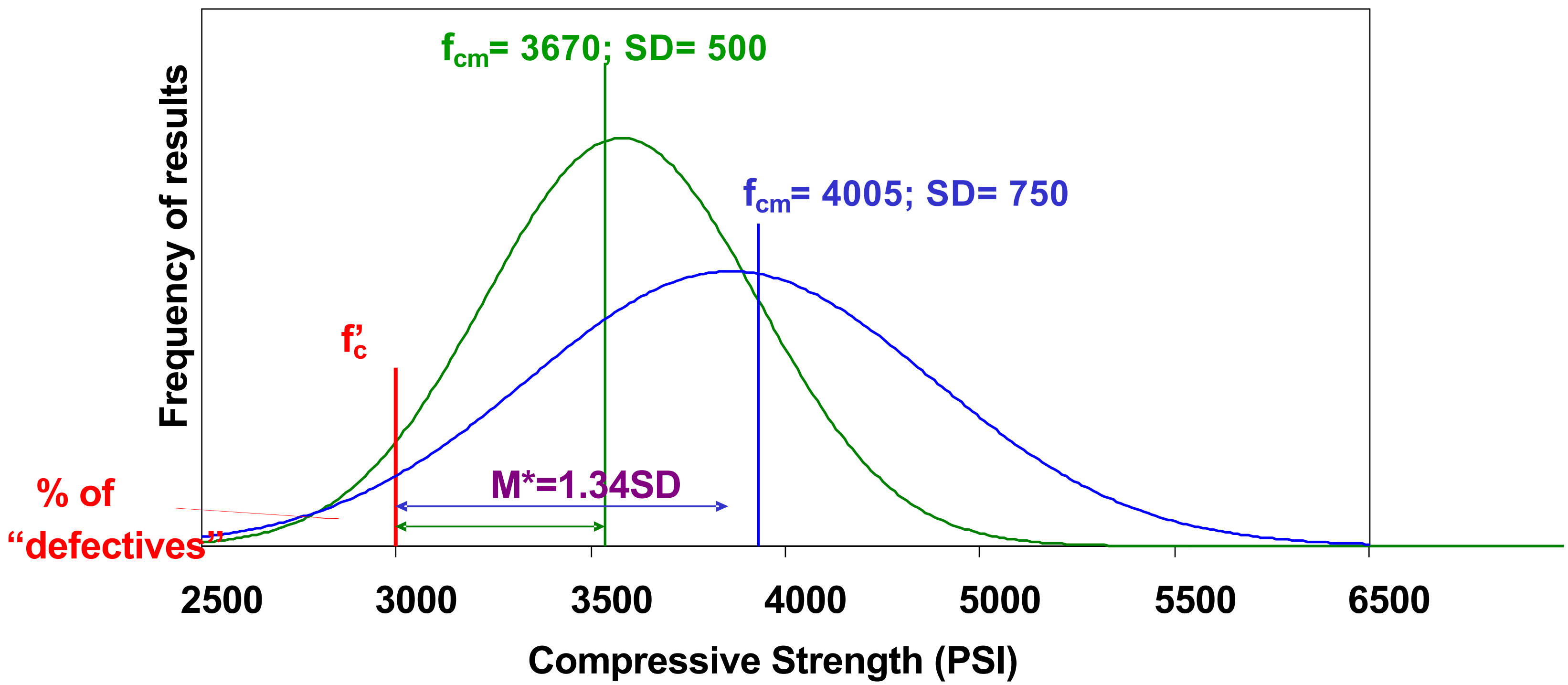
Concrete Mix Design – Methods to reduce CO_2

- Optimize Total Aggregate Gradations (5 – 15%)
- Portland Limestone Cement (6-8%)
- Increased Levels of SCM's (Proportional to reduction)
- Use CO2 Mineralization (3 – 6%)
- All 4 can be done simultaneously



Sustainability vs Over Design

Green mix (SD = 500 psi) requires around **31 lb/yd³ less** cement compared to the Blue Mix (SD = 750 psi)



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Future Strategies to Decarbonize Concrete

Reduce the clinker in cement and concrete

- Produce and use more SCMs to reduce CO_2 and optimize mixes
- Produce more Blended Cements i.e. Type IT(P20)(L10)
- Further develop new SCMs (**calcined clay, ground glass, natural pozzolans**)

Reduce the CO_2 in clinker

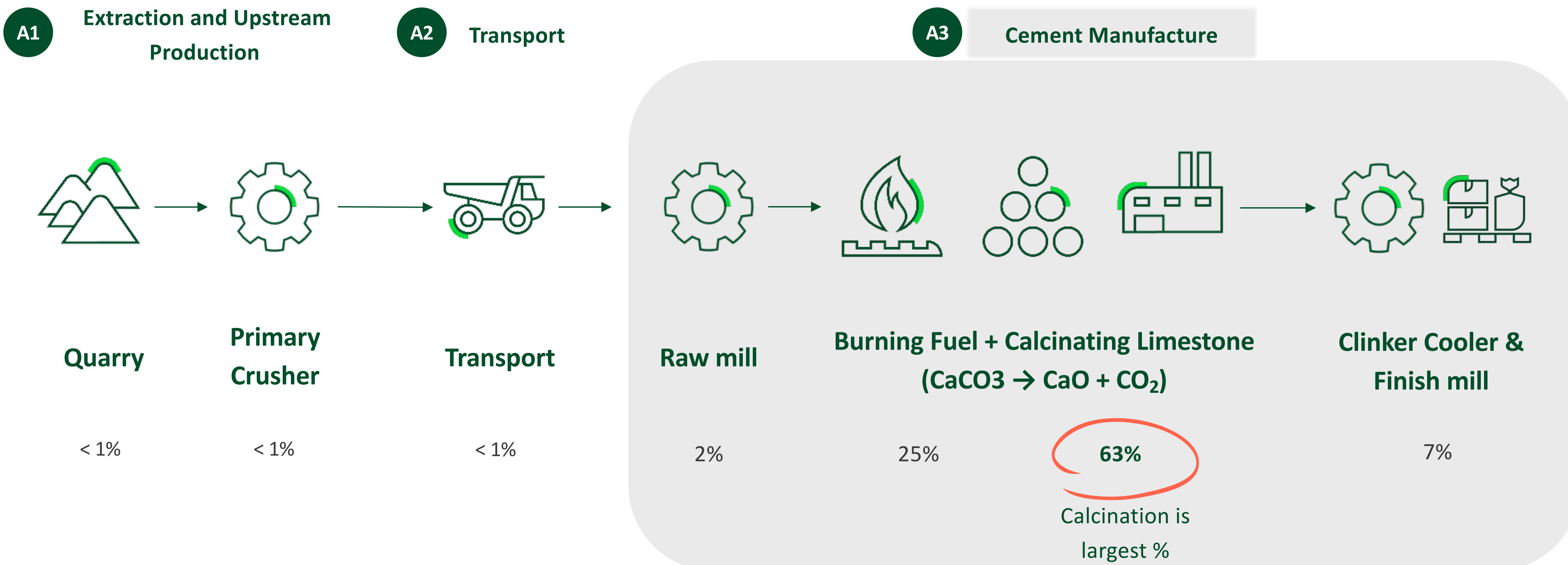
- Increase energy efficiency in production
- Utilize natural gas and Alternative Fuels
- **Develop CCUS technologies for Net Zero Concrete**

Educate users and stakeholders to reduce overdesign

- Utilize real time mix and maturity monitoring
- Optimize concrete mixes/element shapes and right sized design

Understanding the role of calcination in cement's CO_2 emissions

Embodied carbon in cement A1 – A3, "Cradle to Gate"



Carbon Capture & *Permanent* Storage

Storage

- CO_2 to be stored in deep saline reservoirs
- Permanent storage 1,500-3,000 meters below ground in porous brine filled rock under multiple layers of impermeable cap-rock
- Far below potable water and oil and gas reservoirs
- Current known global storage capacity 40 million tons/yr.
- Storage capacity and efficacy subject to MMV (Measurement, Monitoring, and Verification)

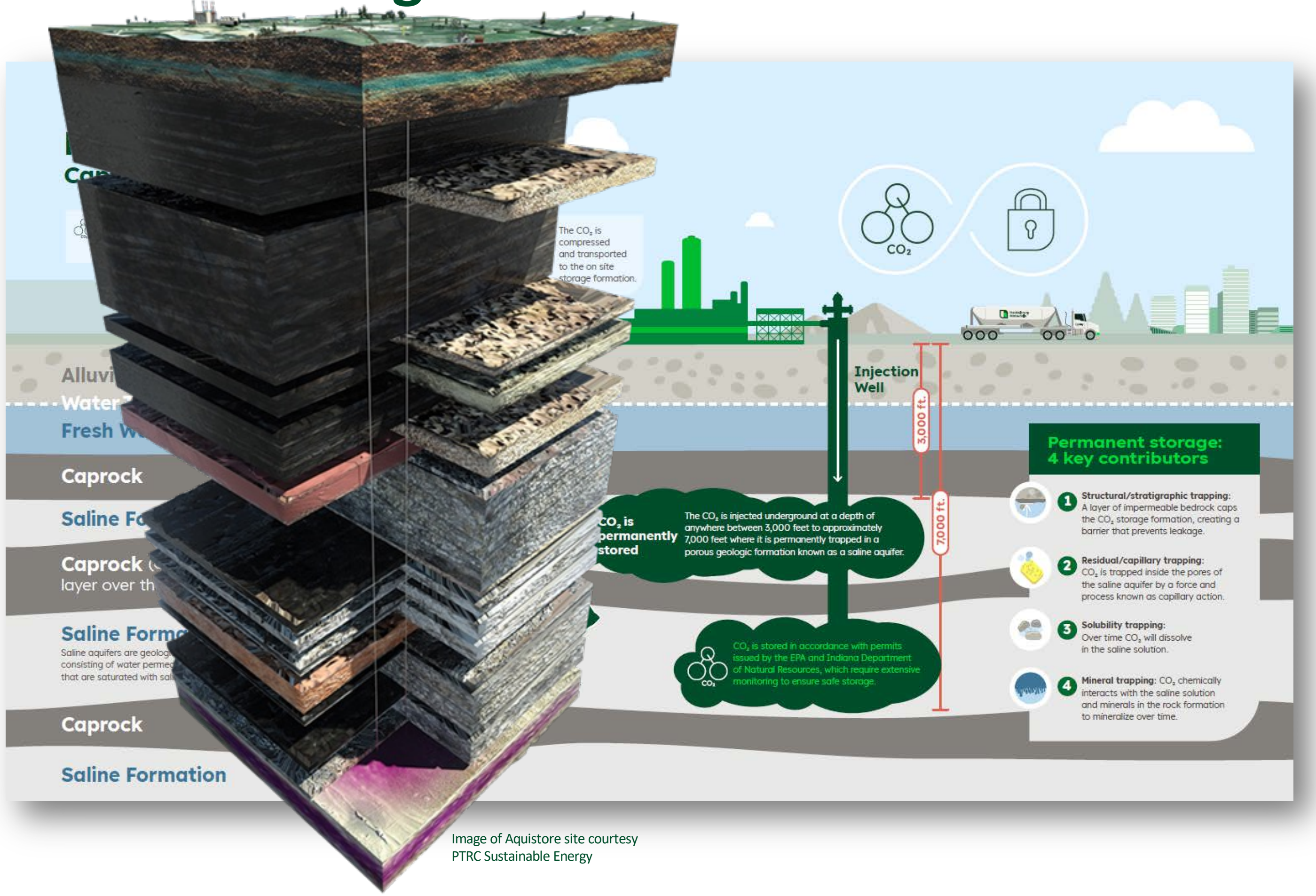


Image of Aquistore site courtesy PTRC Sustainable Energy

Thank you!