

Sustainable Infrastructure

Advances in Concrete Construction

Pacific Northwest AWWA conference
April 2022



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Stantec

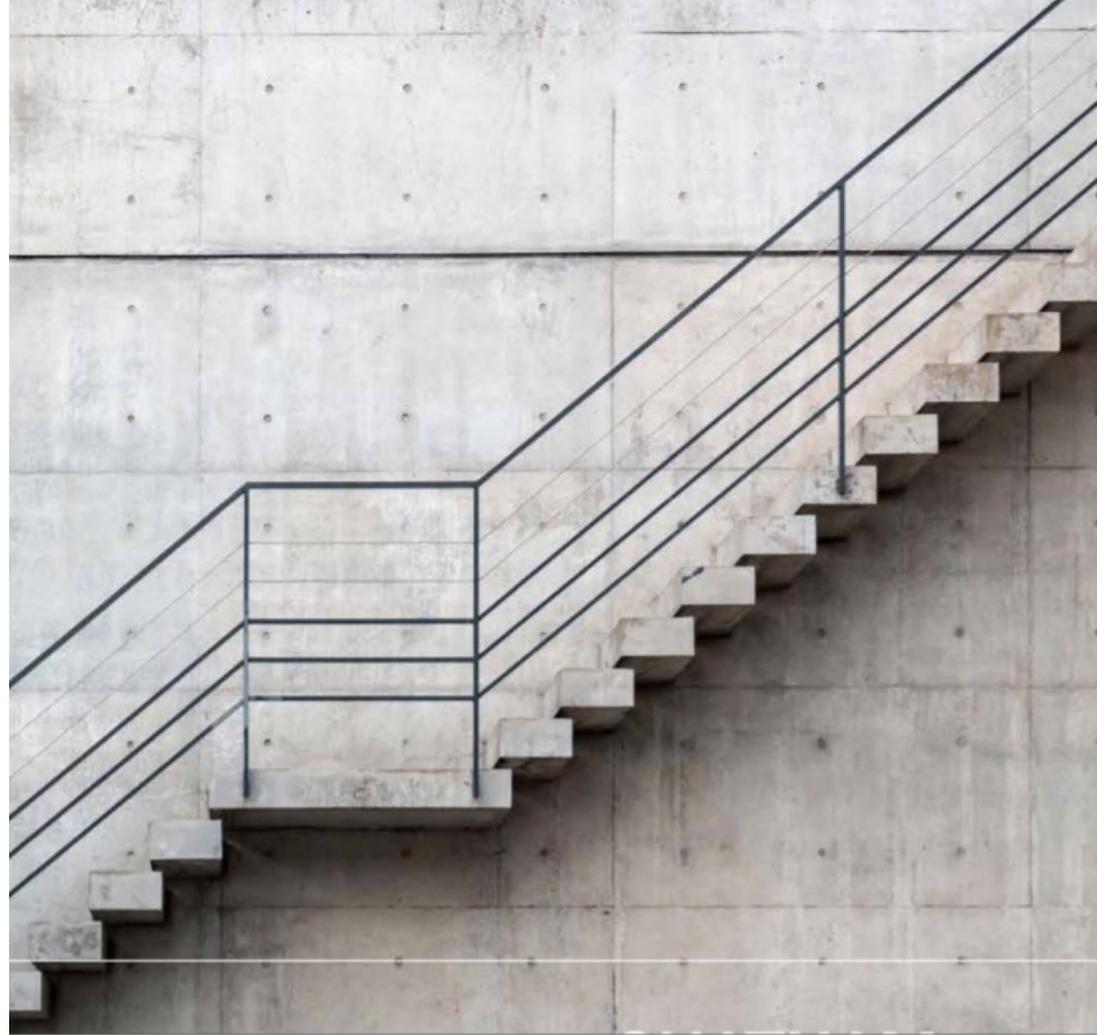
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Environmental Quality



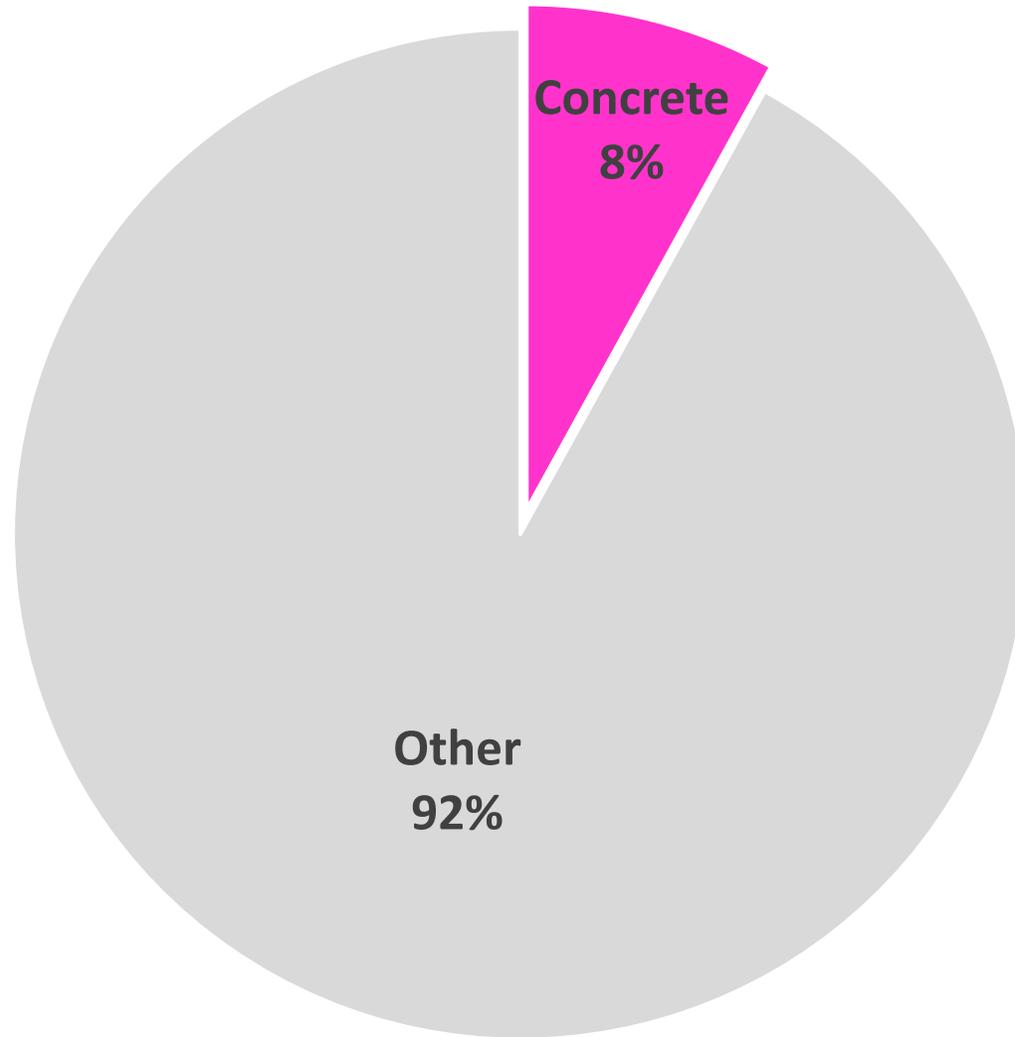
State of Oregon
**Department of
Environmental
Quality**

Presentation Overview

- Why concrete?
- Measuring carbon impacts
- Methods to reduce carbon
- Implementing on your next project
- Looking forward



Global greenhouse gas emissions





China

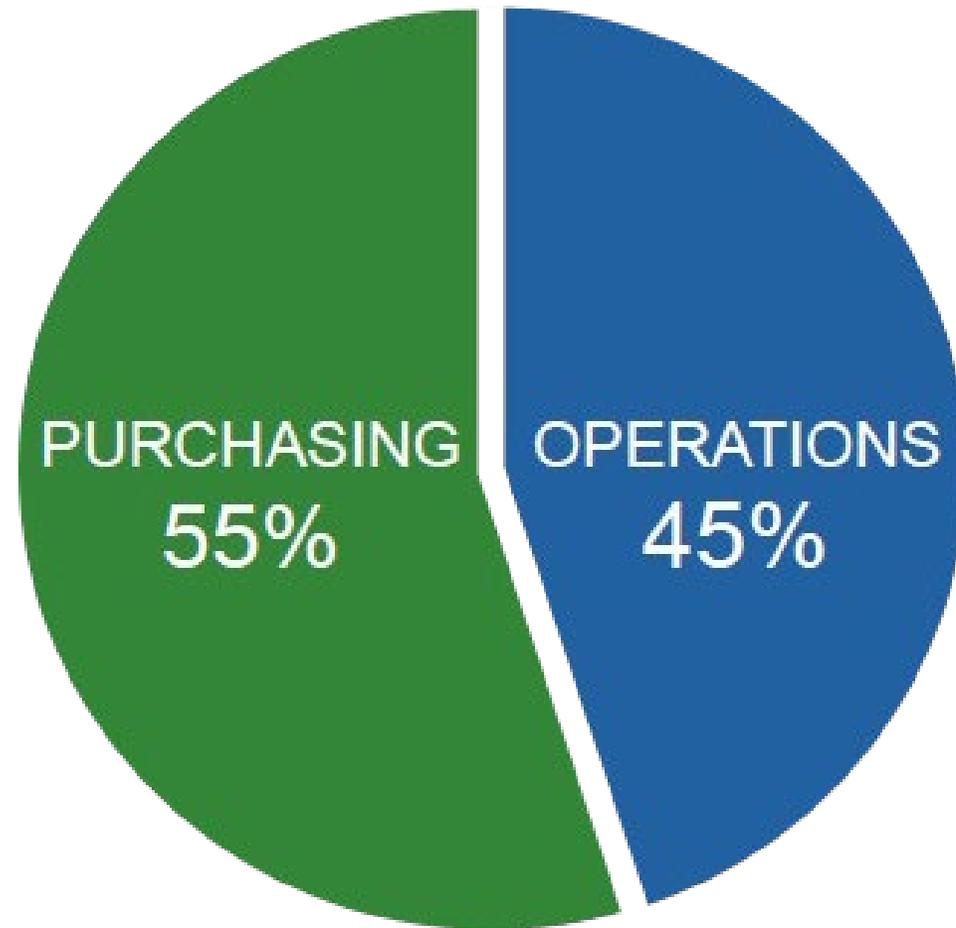


U.S.

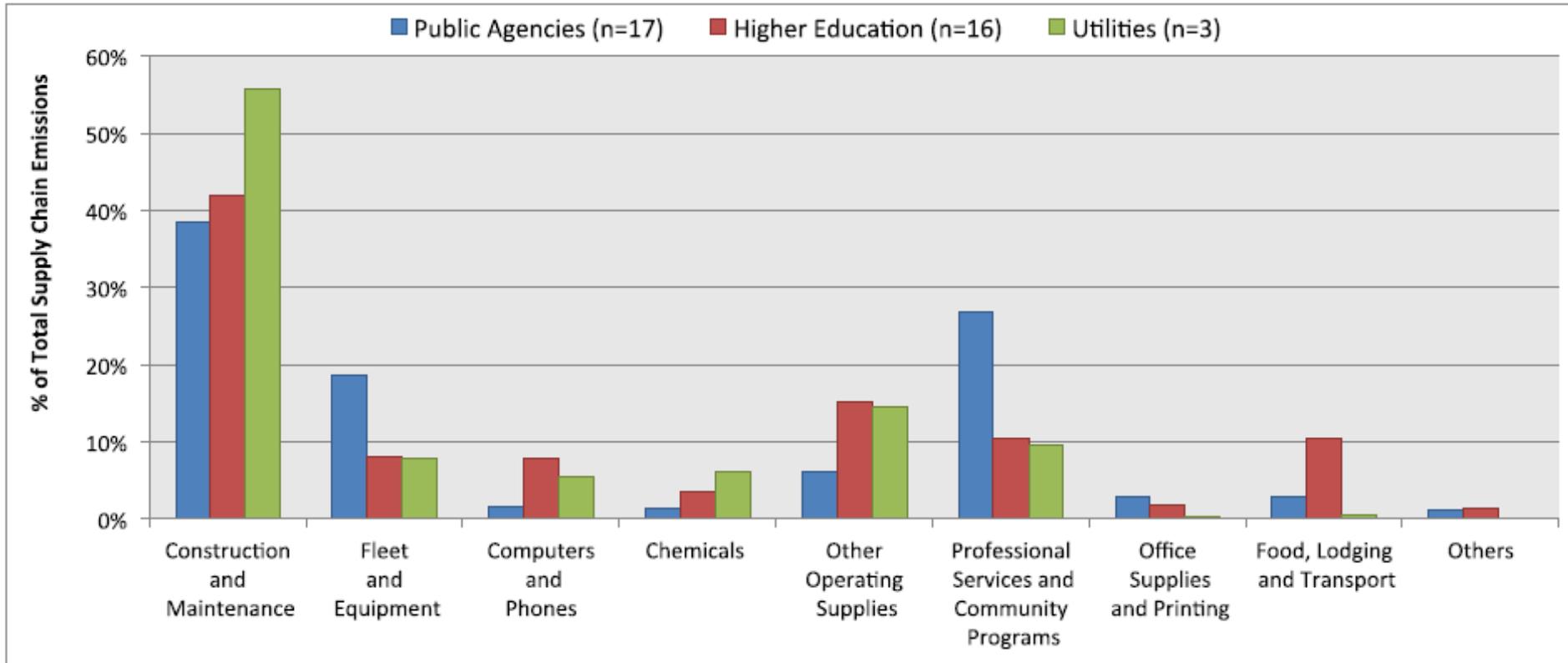


Concrete

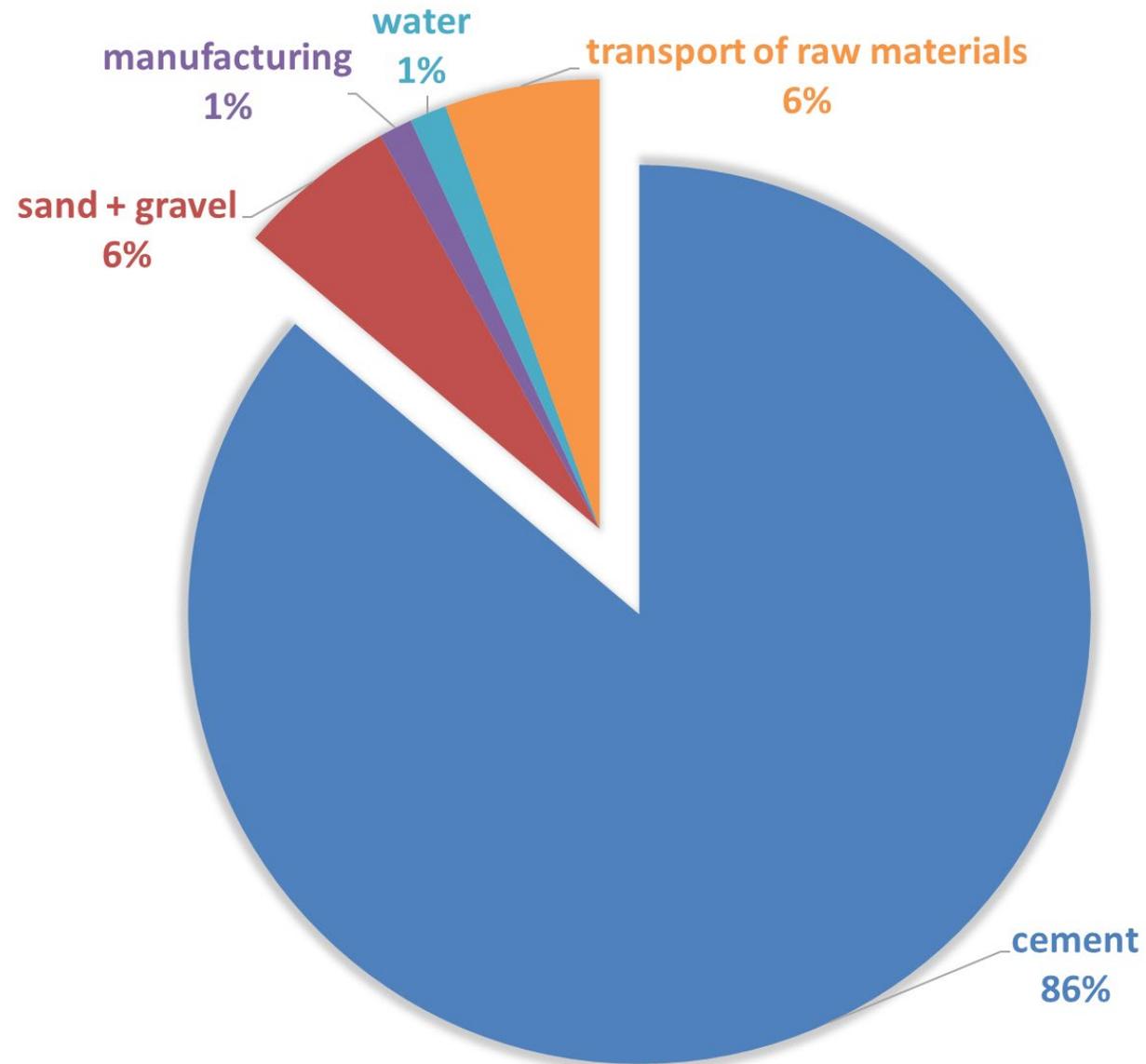
GHG Emissions from Public Institutions



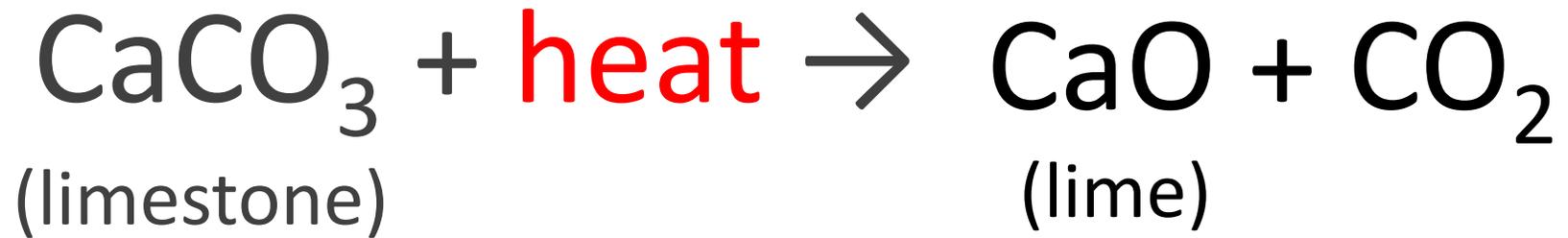
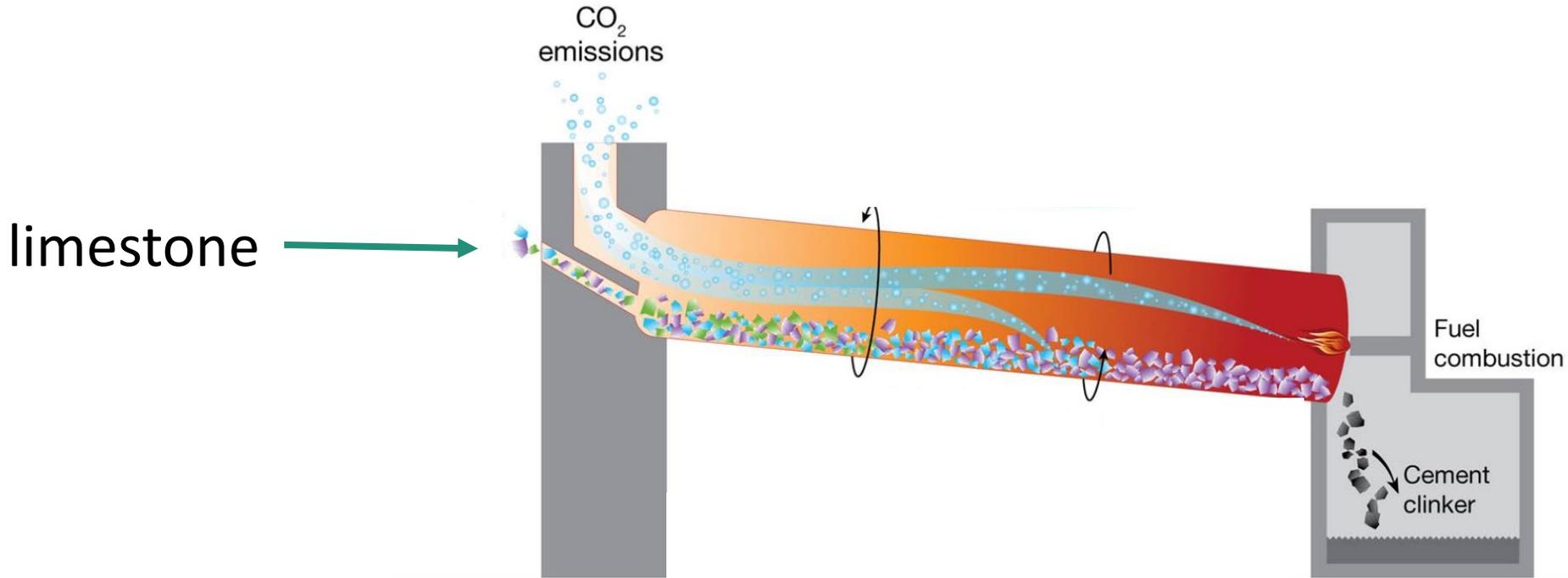
Scope 3 purchasing emissions



Concrete's carbon impact



Cement is carbon intensive



Measuring concrete's carbon impacts

What is an Environmental Product Declarations (EPD)?

- Disclosure label that reports the environmental impacts of products
- Typically include impacts of raw material extraction, transportation, and manufacturing
- Third party certified against ISO standards

ENVIRONMENTAL IMPACTS	
Declared Product: Mix 45SS420A • Bend Plant Exterior SOG Compressive strength: 4000 PSI at 28 days	
Declared Unit: 1 m ³ of concrete	
Global Warming Potential (kg CO₂-eq)	387
Ozone Depletion Potential (kg CFC-11-eq)	9.8E-6
Acidification Potential (kg SO₂-eq)	2.42
Eutrophication Potential (kg N-eq)	0.47
Photochemical Ozone Creation Potential (kg O₃-eq)	58.0
Abiotic Depletion, non-fossil (kg Sb-eq)	1.2E-6
Abiotic Depletion, fossil (MJ)	1,229
Total Waste Disposed (kg)	2.76
Consumption of Freshwater (m³)	2.89
Product Components: natural aggregate (ASTM C33), Portland cement (ASTM C150), batch water (ASTM C1602), slag cement (ASTM C989), admixture (ASTM C260)	

Additional detail and impacts are reported on page three of this EPD

How are EPDs used?

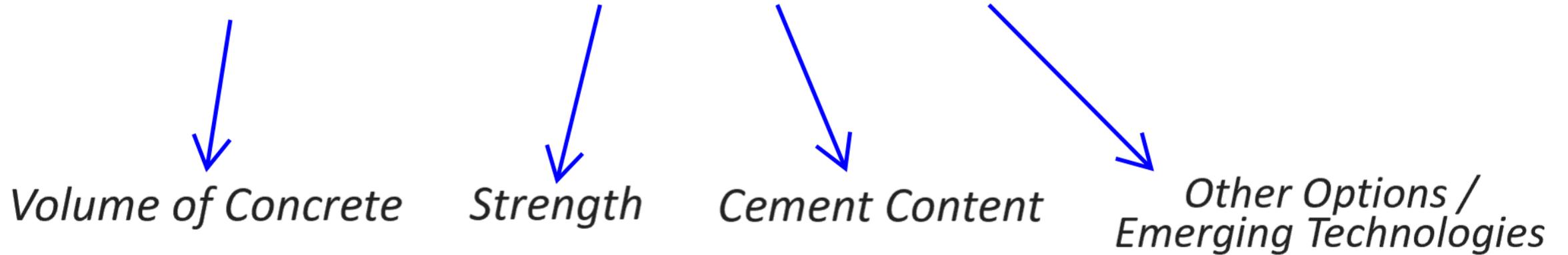
- Manufacturers
 - measure, baseline, and disclose environmental impacts
 - identify process improvement strategies
- Consumers –
 - choose lower impacts products
- Owners
 - achieve “points” in green building/transit rating systems



How to reduce carbon footprint

Reducing the Carbon Footprint

Cubic Yards of Concrete X Carbon Content per Cubic Yard = Carbon Footprint



Reduce the volume of concrete



Reduce the volume of concrete



Reduce the volume of concrete



Reduce the volume of concrete – Life Cycle Analysis

Concrete Durability:

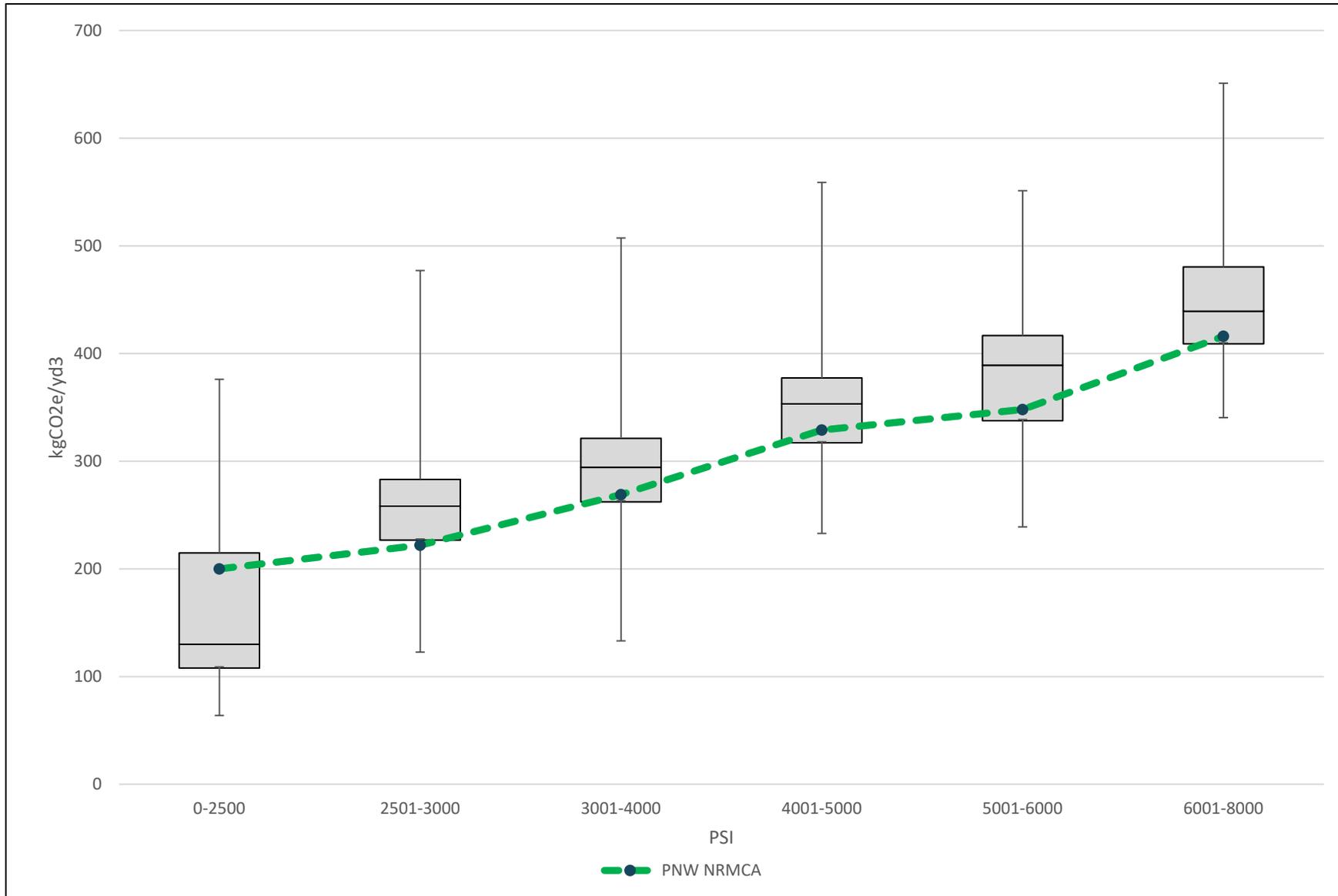
Freezing conditions

Chemical Exposure

Contact with process water



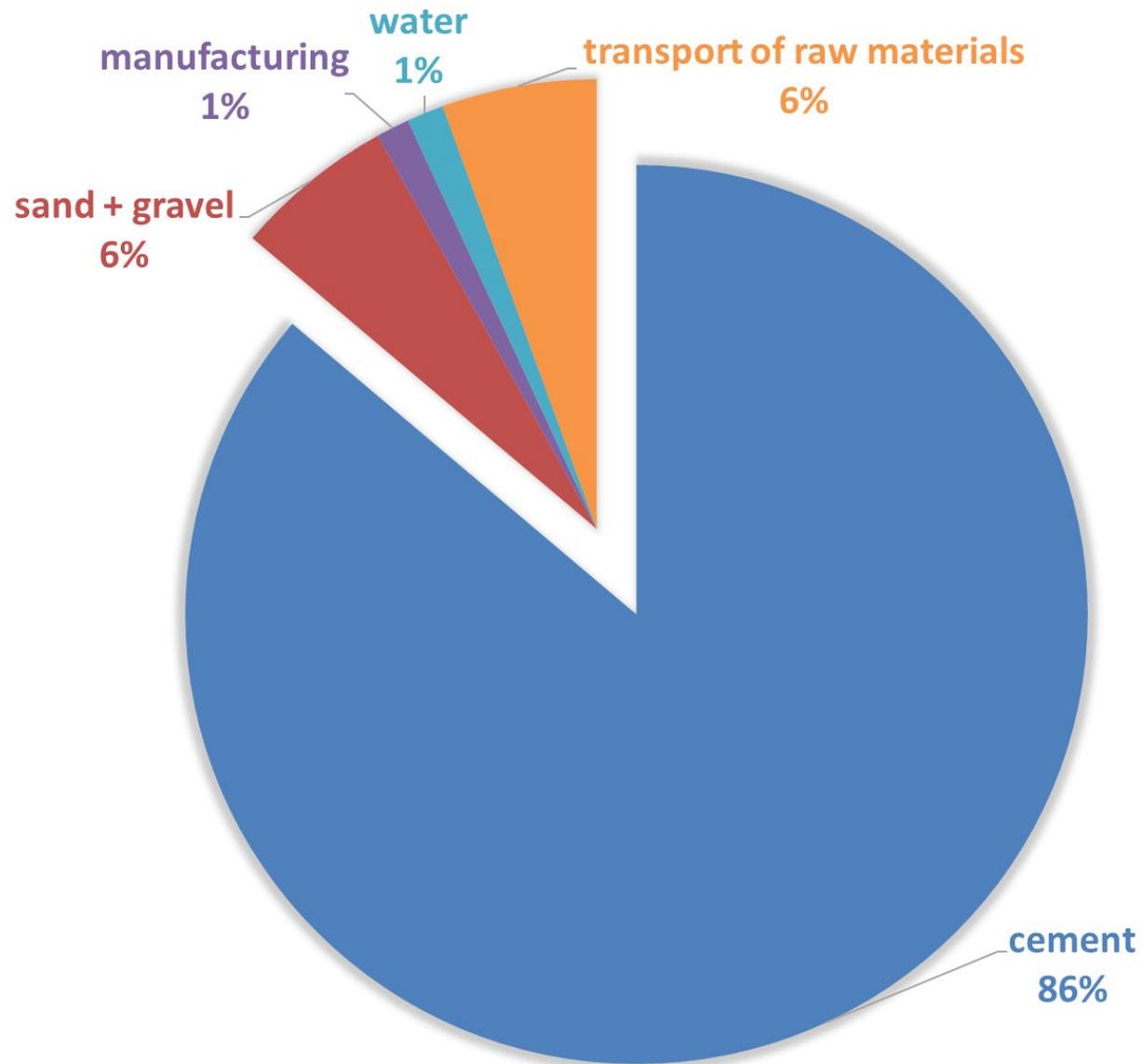
Reduce Strength Requirements



Data description:

- GWP range of the 1100 published EPDs in Portland, OR region
- 17 plants; 4 producers represented
 - Cadman
 - CalPortland
 - Knife River
 - Wilsonville

Concrete's carbon impact



Supplementary Cementitious Materials (SCMs)

Fly ash
pozzolan



Slag

Ground glass
pozzolan



Metakaolin
clay

Natural pumice
pozzolan



New Cement!

Blended Hydraulic Cement: ASTM C595/C595M, Type IL, Portland-Limestone Cement

Used in Europe since the 1960s

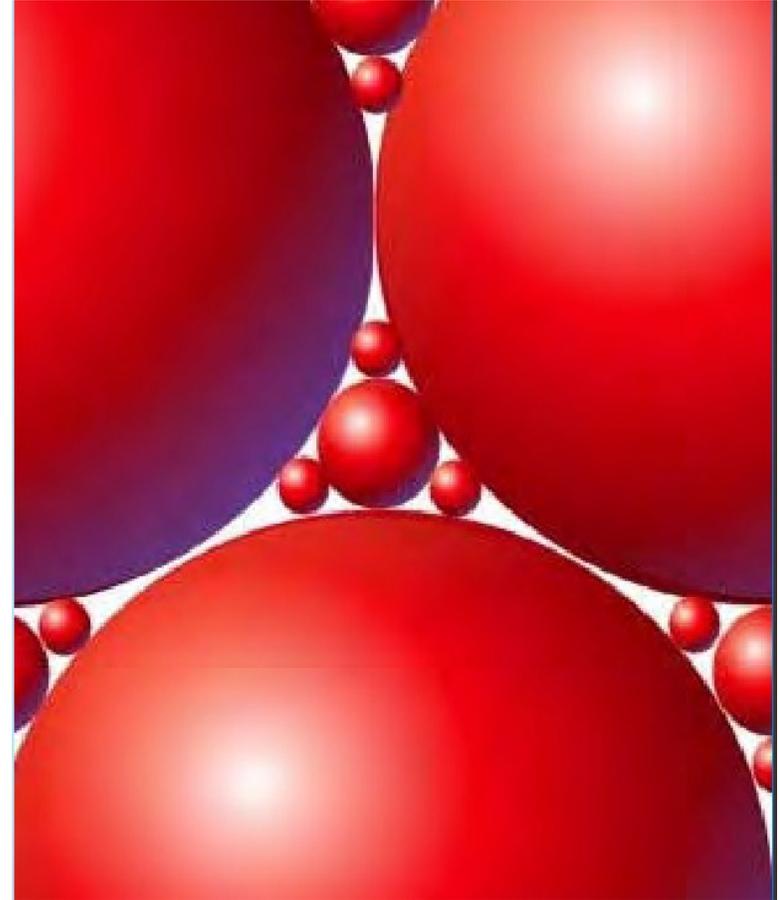
All cements in US allow < 5% limestone

Type IL is 15% limestone

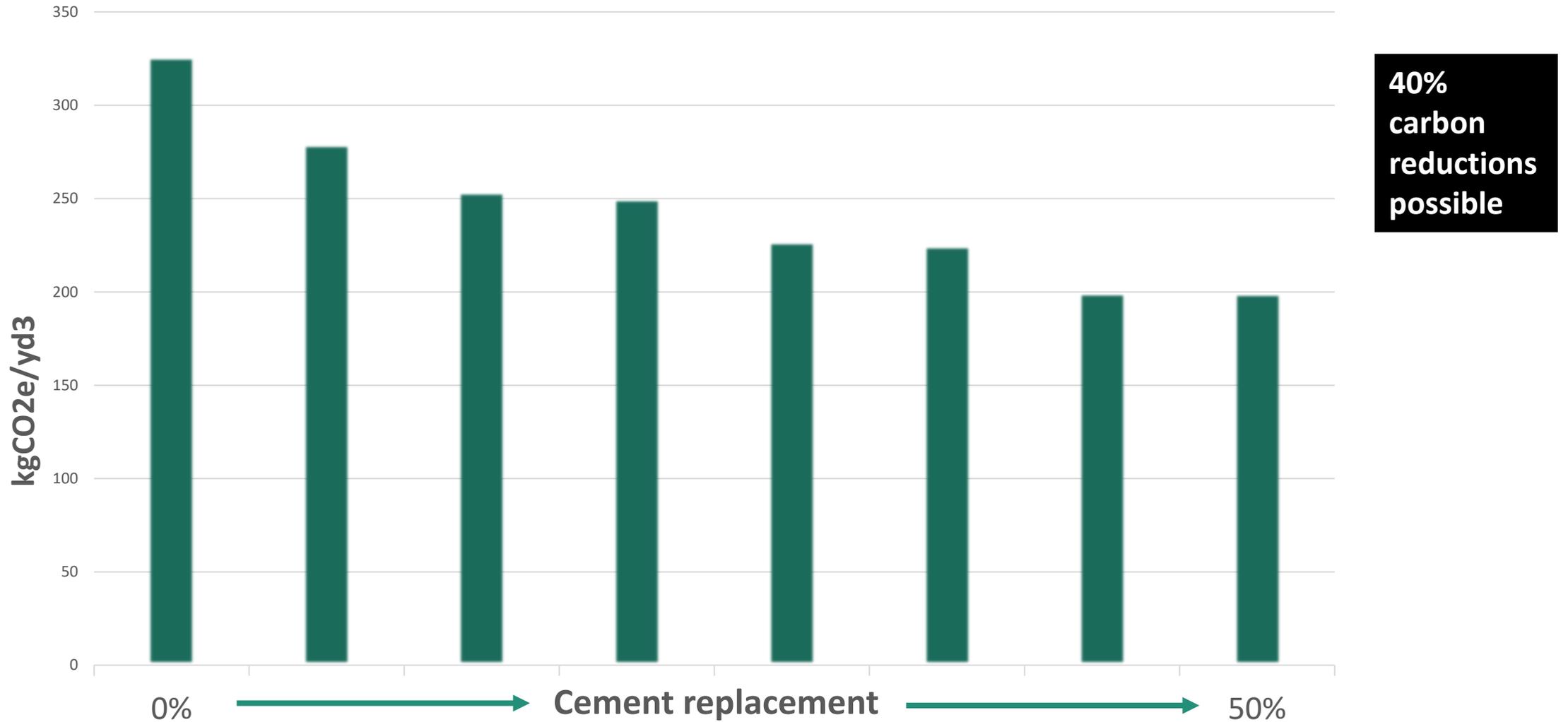


Durability benefit of SCMs and Type II

Particle packing, increased density, decrease permeability



2019 average US carbon impact of 4000 psi concrete



**40%
carbon
reductions
possible**

Additional carbon reduction strategies

- Injected CO₂ mineralization (Carbon Cure)
- Closed chamber cured cements (Solidia)
- Use hard, clean, and strong aggregates
- CO₂ sequestering aggregate (Blue Planet)
- High strength reinforcing steel
- Others!!



Implementing on your next project

Implementing on your next project

1. Each concrete mix EPD shall demonstrate the embodied carbon does not exceed the values listed in the following table:

Embodied Carbon	
Concrete Strength (psi)	Kg CO2e per cubic yard
2500	180
3000	200
4000	269
4500	269
5000	295

Implementing on your next project

Prescriptive Specification	Performance Specification
Min / Max cement	ACI exposure classifications
Min / Max slag or fly ash	Max. Aggregate Size
Branded admixtures	Compressive strength
High early strength	Require EPDs and a limit carbon content

Looking forward

EPDs in rating systems

Points for EPDs
and embodied
carbon reduction



Requirements to
measure and reduce
embodied carbon



**LIVING
BUILDING
CHALLENGE**



CARBON
CERTIFICATION

EPDs for public purchasing

BUY 
CLEAN



Other State Efforts:

- Oregon
- Washington
- Minnesota
- New York

Federal Efforts:

- Buy clean Procurement Requirements

EPDs for concrete - City of Portland Policy



- Jan 1, 2020
 - EPDs required on all City projects
- March 1, 2022
 - City publishes GWP threshold
- January 1, 2023
 - All EPDs must be below threshold

Questions?

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