3 Part Series:
Part 1 - Concrete's Environmental Impacts and Ability to Impact a Company's Environmental Social and Governance Scores

Luke McHugh, P.E.
Senior Director – Local Paving
National Ready Mixed Concrete Association

March 9, 2021

National Ready Mixed Concrete Association

- National Trade Association – Established in 1930
- HQ in Alexandria, VA
- 1,400+ Member Companies
- NRMCA Represents ~75% of North American Ready Mixed Production
- Mission - Serve Industry and Partners Through:
  - Compliance and Operations
  - Engineering
  - Government Affairs
  - *Structures and Sustainability: Build With Strength™ Initiative*
  - ***Local Paving: Pave Ahead™ Initiative (PaveAhead.com)***

NRMCA Local Paving Division:
Technical and Promotion Personnel - Regional Assignments

Brian Killingsworth, P.E.
Executive Vice President
Team Lead

Ken Justice, P.E.
Senior Director
Midmidwest

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Senior Director
Northeast

Don Clem, P.E.
Vice President
Northwest

Phil Kresge
Sr. Vice President
East Central

Jon Hansen
Senior Vice President
Southwest

Amanda Hult, P.E.
Senior Director
Southeast

LED	CFL	Incandescent
Avg Life: 25,000 Hrs	Avg Life: 8,000 Hrs	Avg Life: 1,200 Hrs
No Mercury	Mercury	No Mercury
6-8 Watts	13-15 Watts	60 Watts
Uses 84% less energy	Uses 75% less energy	90% energy lost to heat

Nick Holonyak, Jr. 1962 **Edward Hammer 1976** **Thomas Edison 1878**

INCANDESCENT vs. LED

Good

BETTER

- ✓ Slightly higher initial cost
- ✓ Improved materials
- ✓ Increased lifespan
- ✓ Replace less frequently
- ✓ Less energy use
- ✓ Less wasted energy
- ✓ Better for environment

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- ✓ Improved materials
- ✓ Increased lifespan
- ✓ Replace less frequently
- ✓ Less energy use
- ✓ Less wasted energy
- ✓ Better for environment

Good **BETTER**

RESILIENT and SUSTAINABLE

- Full-Depth Conventional Concrete
- Concrete Overlay of Existing Asphalt
- Roller-Compacted Concrete (RCC)
- Full Depth Reclamation (FDR) Using Cement Slurry

Resilient and Sustainable

CONCRETE PAVEMENTS

Concrete Overlays of Existing Asphalt

Roller-Compacted Concrete Pavement

Full Depth Reclamation with Cement Slurry

Performance Benefits of a Concrete Pavement

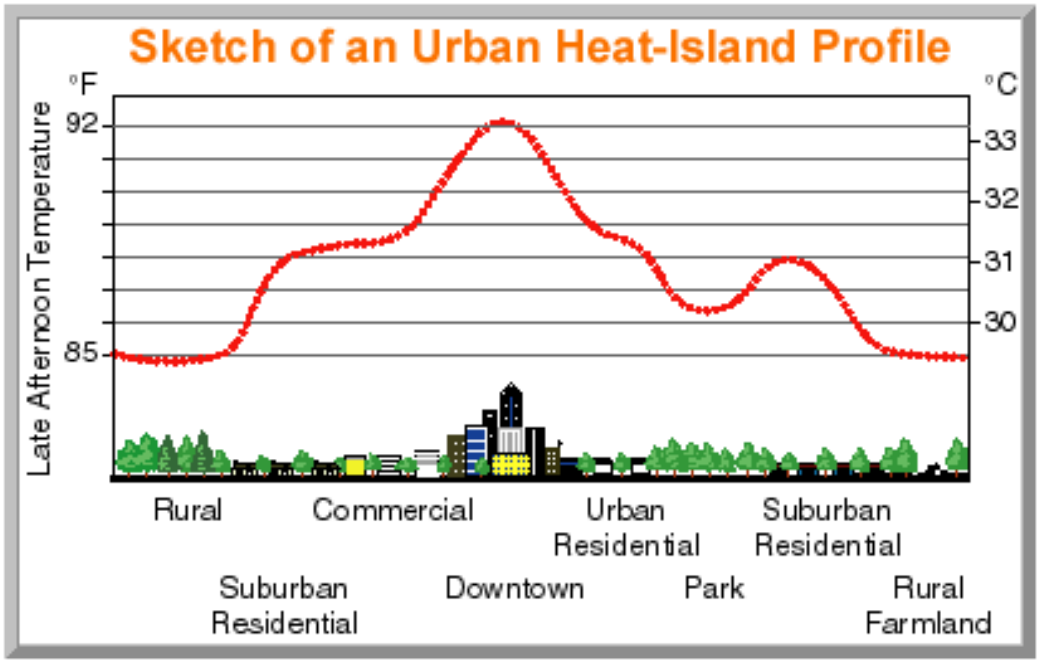
- Proven long life
- No potholes, rutting, shoving
- Evenly carries heavy loads
- Resistance to freeze/thaw

Environmental Benefits of a Concrete Pavement

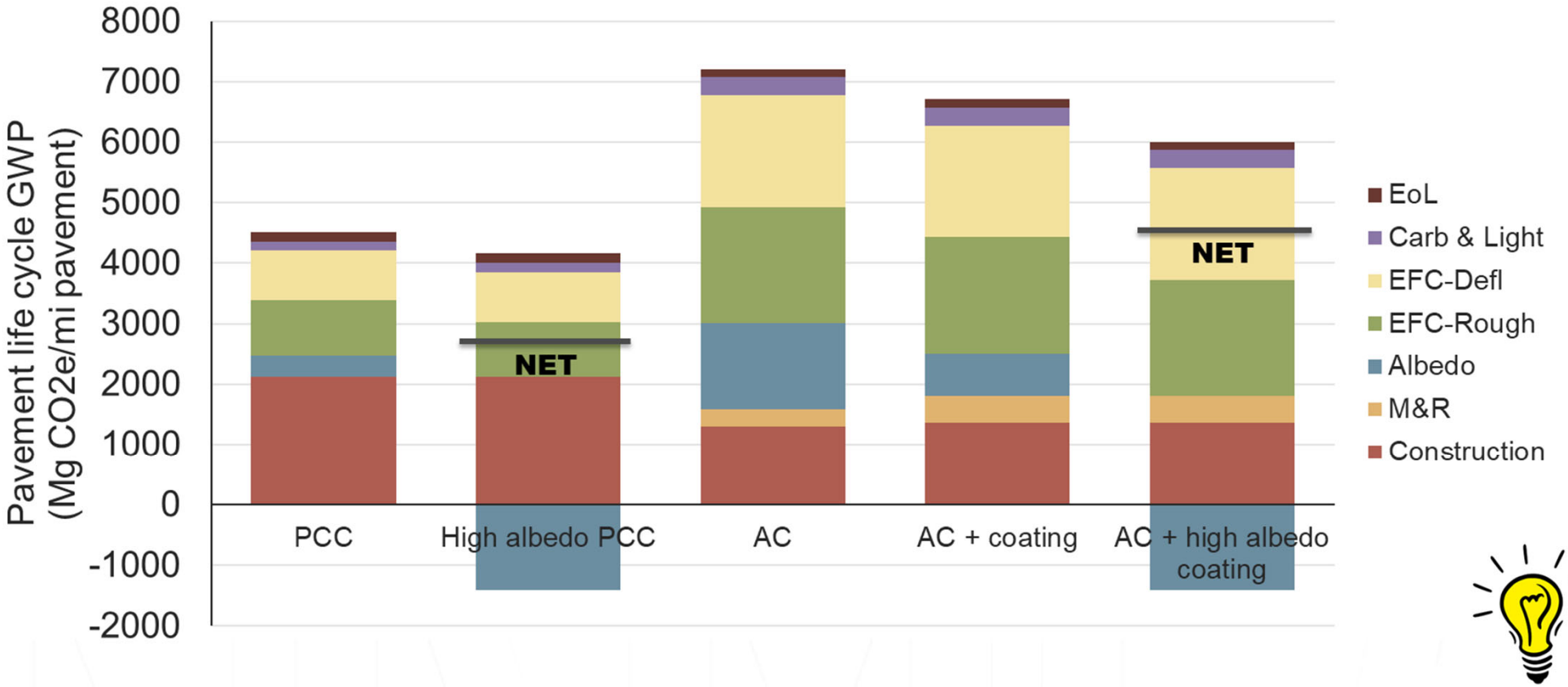
- Uses less raw materials
- No hazardous materials
- Recycled materials can be used
- Conserves petroleum resources
- Does not pollute waterways

Heat Island Mitigation

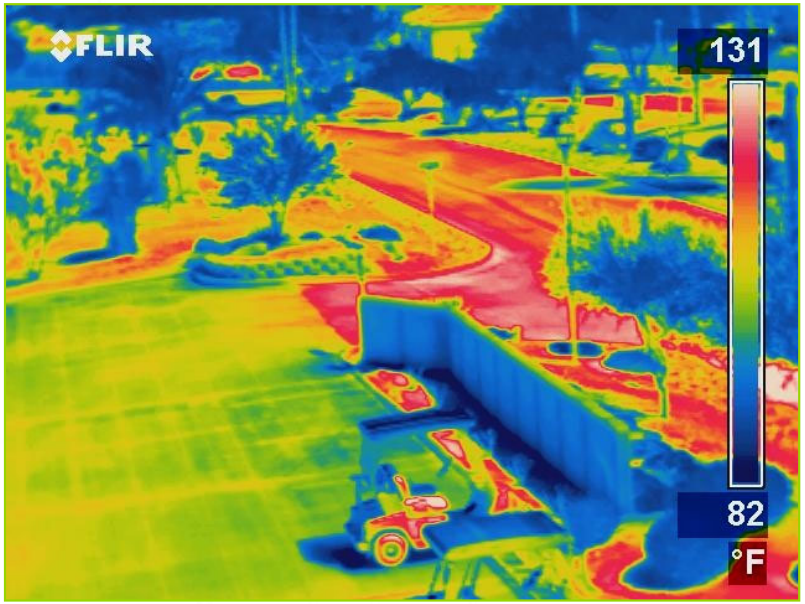
- Concrete's lighter color means less heat absorption
- Lowers ambient air temperature by 7 to 10 degrees
- 1 degree equals 1.5% change in energy consumption



Pavement Albedo



Concrete Pavements can Reduce Global Warming Potential by 50%

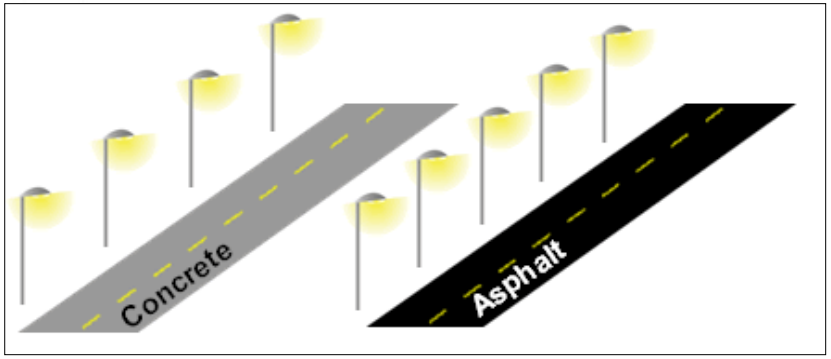


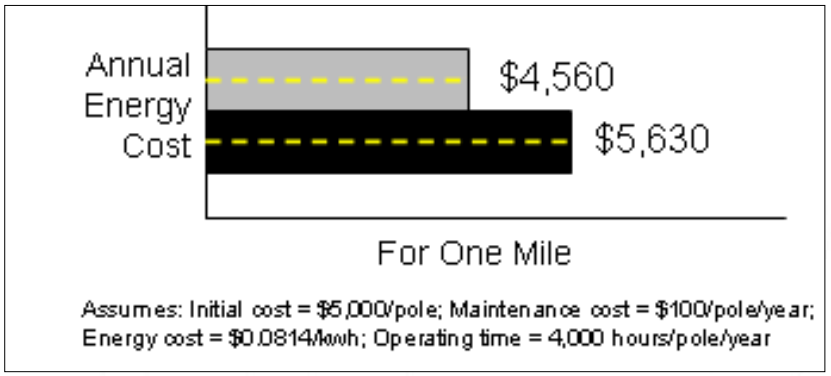
Photos courtesy of the American Concrete Pavement Association

Energy Savings and Illumination

Higher reflectivity reduces lighting requirements

Nearly 25% reduction in energy costs for lighting






SCHOOL

SUSTAINABILITY

Pavement Sustainability - Definition

Refers to system characteristics that encompasses a pavement's ability to:

1. achieve the engineering goals for which it was constructed,
2. preserve and (ideally) restore surrounding ecosystems,
3. use financial, human, and environmental resources economically, and
4. meet basic human needs such as health, safety, equity, employment, comfort, and happiness.

FHWA-HIF-15-002, Towards Sustainable Pavement Systems: A Reference Document, January 2015

Pavement Sustainability – Broad Impacts

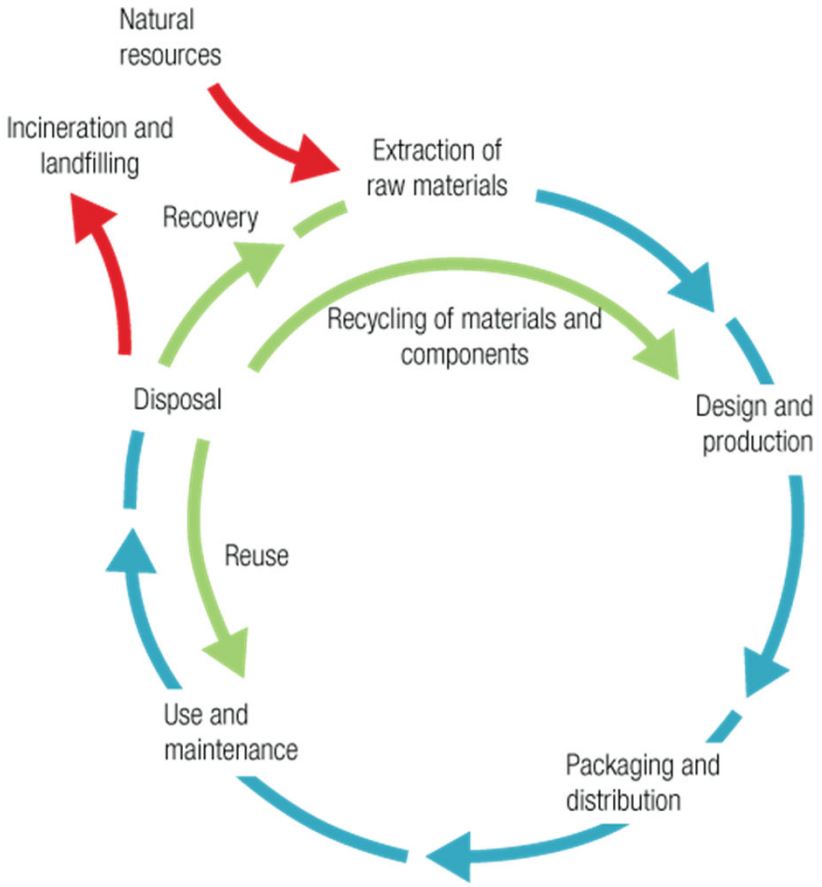
- **greenhouse gas (GHG) emissions**
- energy consumption
- impacts on habitat
- water quality
- changes in the hydrologic cycle
- air quality
- mobility
- access
- freight
- community
- depletion of non-renewable resources
- economic development

FHWA-HIF-15-002, Towards Sustainable Pavement Systems: A Reference Document, January 2015

The basis of evaluating environmental impacts

LIFE CYCLE THINKING

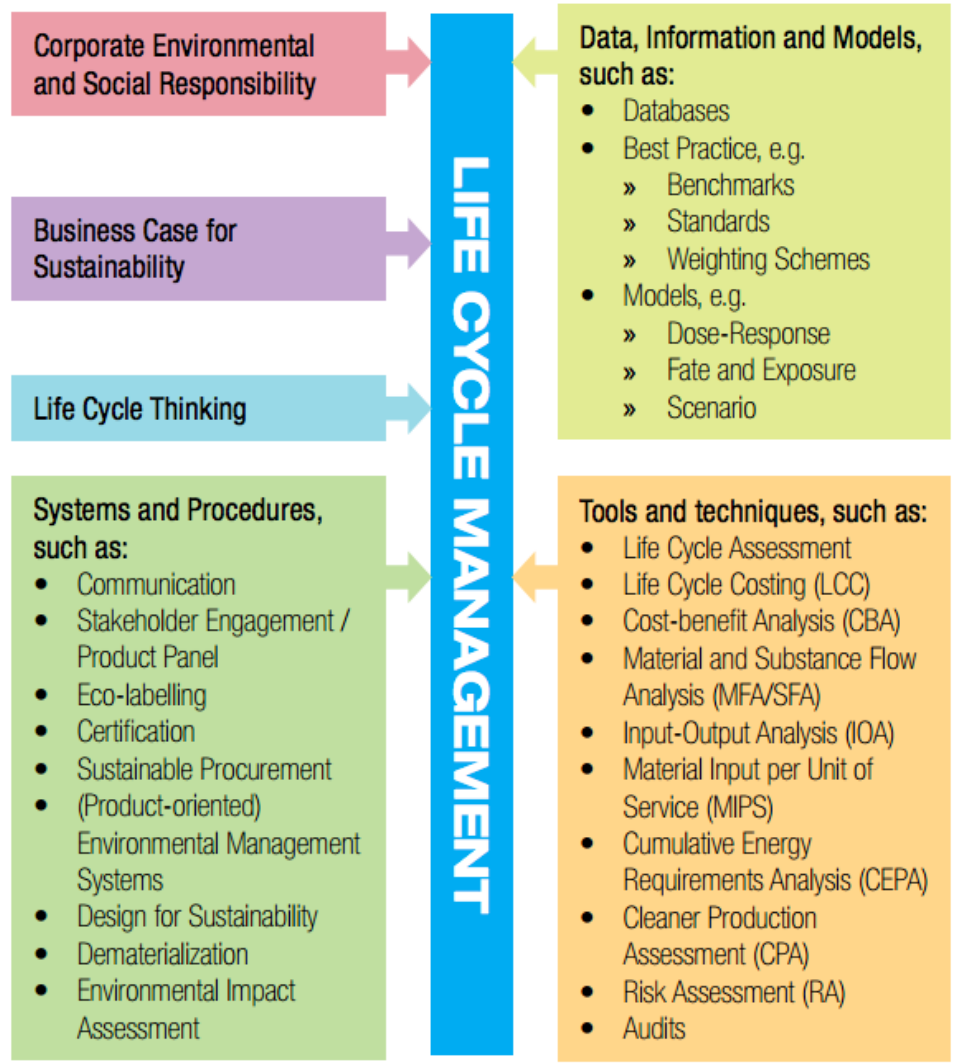
Life Cycle Thinking (LCT)



- Reduce a product's resource use and emissions to the environment.
- Improve its socio-economic performance through its life cycle.

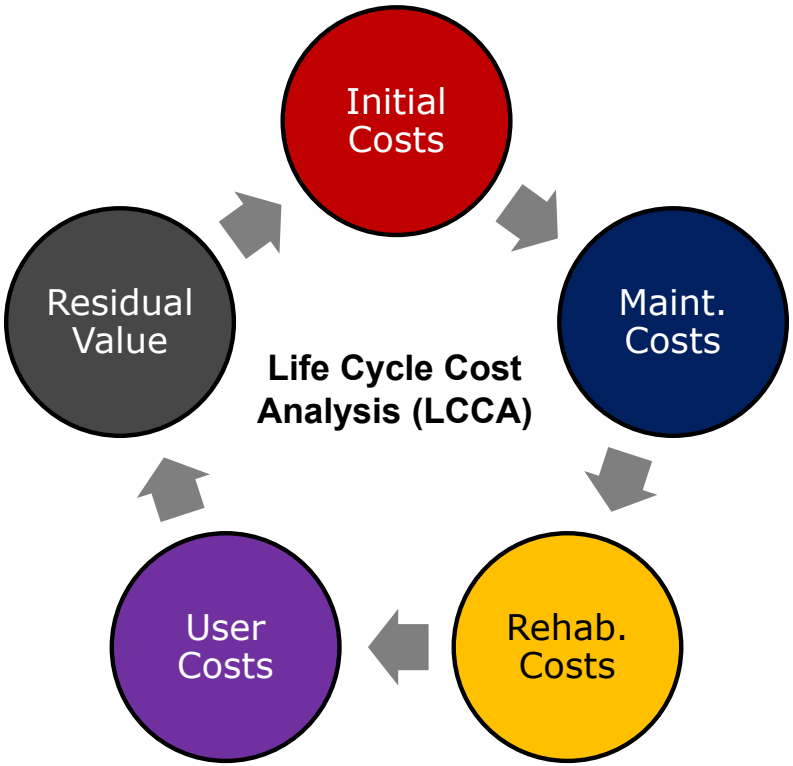
Life Cycle Initiative

Life Cycle Management (LCM)

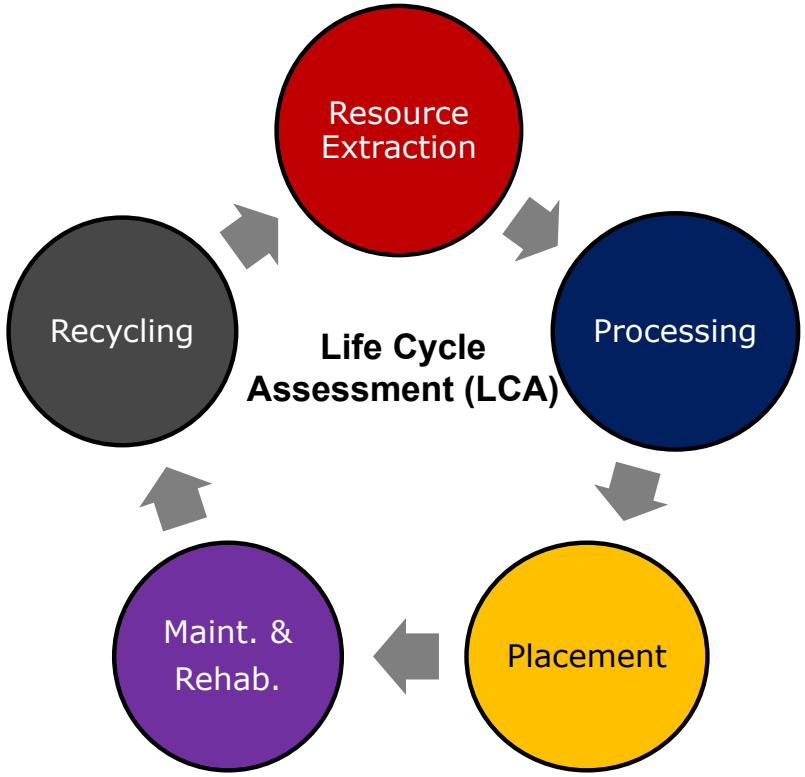


Source: UNEP/SETAC. Life Cycle Management: A Business Guide to Sustainability. Paris, 2007.

Life Cycle Cost Analysis vs. Life Cycle Assessment

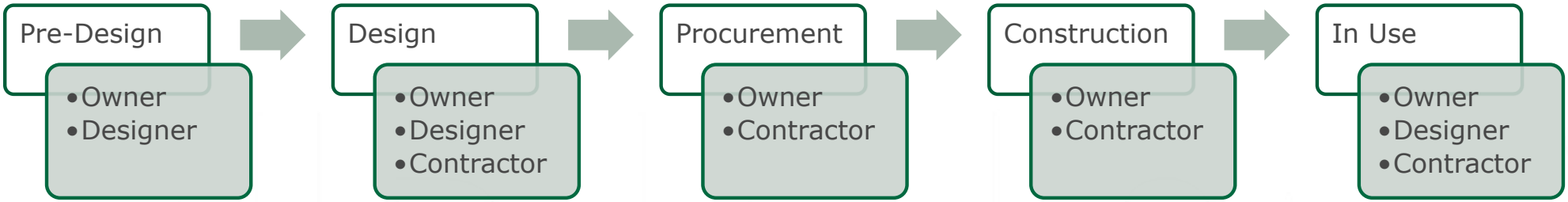


Economic Considerations



Environmental Considerations

Life Cycle Thinking



SUSTAINABILITY: CORPORATE

ESG

Environmental, social and corporate governance

ENVIRONMENTAL

SOCIAL

GOVERNANCE

Environment
Environmental policy
Environmental performance
Climate change
Nuclear energy
Biodiversity

Social
Human rights
Labour standards
Health and safety
Employee development
Supply chain standards

Governance
Corporate governance
Code of ethics
Bribery and corruption
Death penalty
Military expenses


XPOLogistics


ups


DHL


PROLOGIS


FedEx


amazon

ESG: Environmental Social Governance

Scope 1 emissions are direct emissions from company-owned and controlled resources.

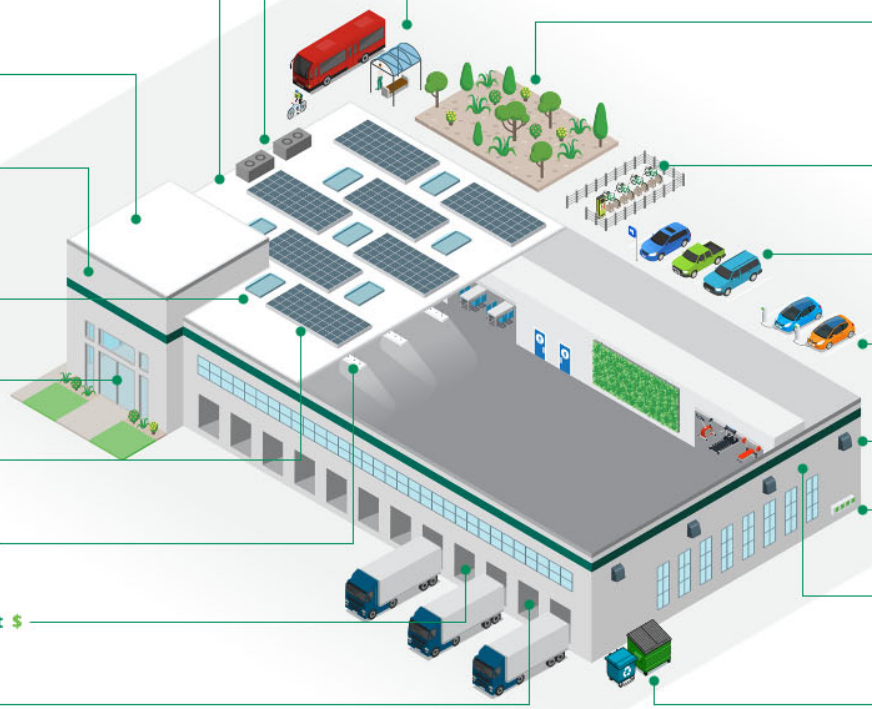
- Company facilities
- Company vehicles

Scope 2 emissions are indirect emissions from the generation of purchased energy, from a utility provider.

- Purchased electricity, steam, heating & cooling for personal use

Scope 3 emissions are all indirect emissions – not included in scope 2 – that occur in the value chain of the reporting company, including both upstream and downstream emissions.

- Leased assets
- Employee commute
- Business travel
- Waste from operations
- Transportation & distribution
- Fuel & energy related
- Capital goods
- Purchased goods & services



Low emission, energy efficient HVAC
Reduce output when building is unoccupied

Cool roofs
Reflect sunlight and repel heat, lowering indoor air temperature

High efficiency roofing and wall materials
Optimize interior temperatures

20-30 percent regionally sourced building materials
Reduce transportation emissions and boost local economies. Use of bio based, circular building materials

Skylights $
Reduce daytime electricity use

Real-time energy monitoring
Inform employees and create awareness

Solar panels $
Turn rooftops into sources of clean energy

LED lighting with dynamic controls $
Improve illumination and reduce energy costs

Energy saving mode of dock equipment $
Preserve energy when not in use

Dock levers with gap sealing and dock shelters with bottom cushion
Seal interior to the elements

Access to public transportation options
Public transport, shuttles, bicycle rental and car sharing

Drought-tolerant plants and rainwater collection
Decrease water usage, reproduce local ecosystems and support biodiversity with insect hotel, bird houses, edible trees and greenery

Secured bicycle shed with E-bike charging

Carpool/car sharing dedicated parking spots

Electric car (EV) charging stations and dedicated car sharing parking spots
Reduce emissions for daily commuters

Exterior LED lighting
Reduce light pollution and energy costs

Smart energy meters
Monitor energy in real time to reduce energy expenditures

Low-emitting paint, sealants and insulation
Lower environmental impact than conventional paint products

Areas for storage and collection of recyclables
Minimize environmental impact

$ = Direct occupational cost savings

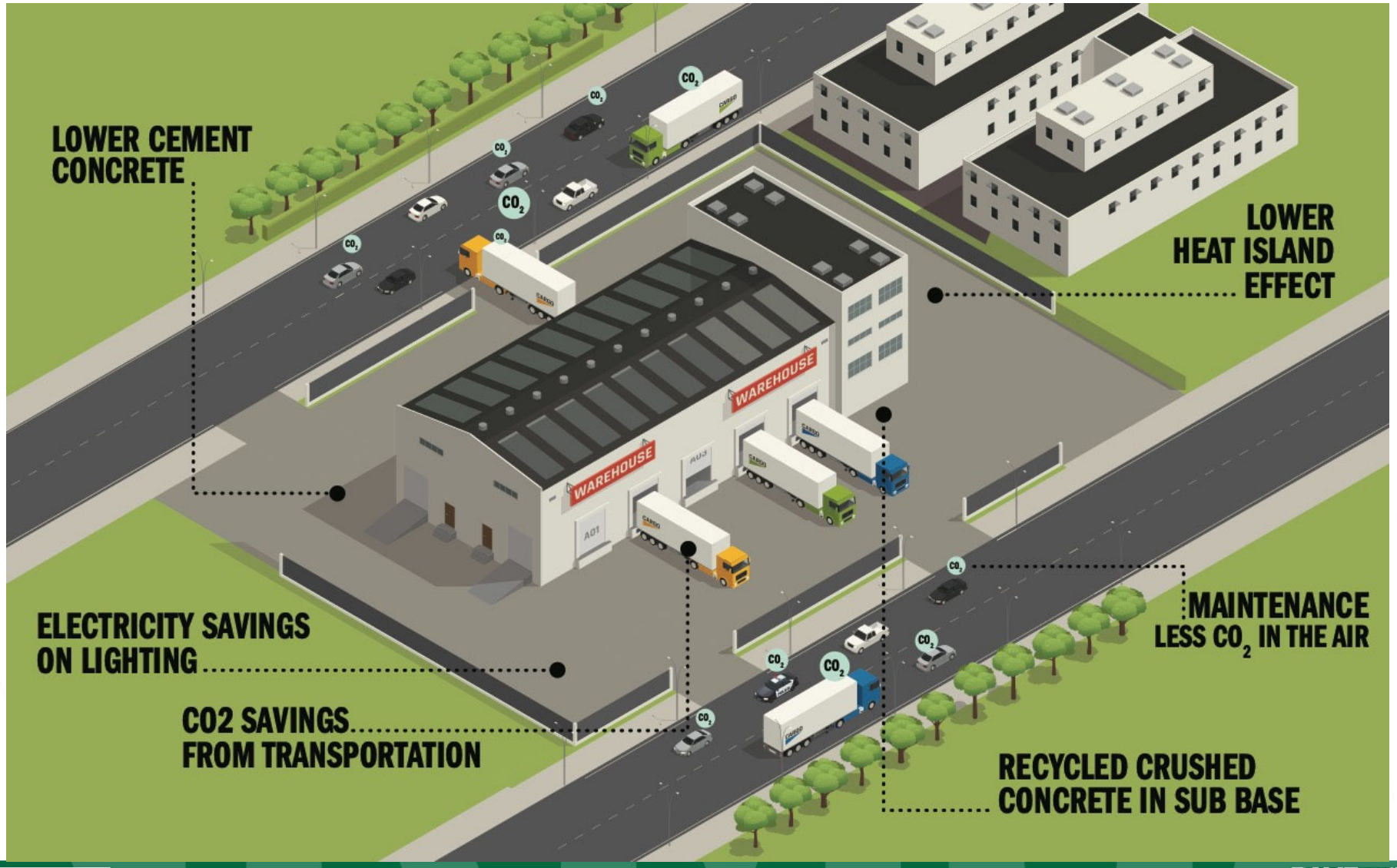
BREEAM CASBEE WELL DGNB HQE BOMA

BUILDING CERTIFICATIONS
Demonstrate that we build to the top sustainability standards

ISO

PROJECT MANAGEMENT CERTIFIED
ISO 14001

Source: Prologis


LOWER CEMENT CONCRETE
LOWER HEAT ISLAND EFFECT
WAREHOUSE
WAREHOUSE
ELECTRICITY SAVINGS ON LIGHTING
CO2 SAVINGS FROM TRANSPORTATION
MAINTENANCE LESS CO_2 IN THE AIR
RECYCLED CRUSHED CONCRETE IN SUB BASE

SUSTAINABILITY: MATERIALS

1 ton CO_2 per 1 ton Portland cement

1 ton CO_2 per 1 ton Portland cement

- 50 – 60% from calcination of calcium carbonate raw materials

1 ton CO_2 per 1 ton Portland cement

- 50 – 60% from calcination of calcium carbonate raw materials
- **Carbonation** of concrete accounts for 30 - 50% uptake of CO_2

- 420 to 650 lbs. cementitious per yd^3 concrete

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- 15 to 30+% Supplementary Cementitious Material (SCM) replacement

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- Embodied CO_2 per yd^3 equals 170 to 480 lbs.

  <15% of total weight

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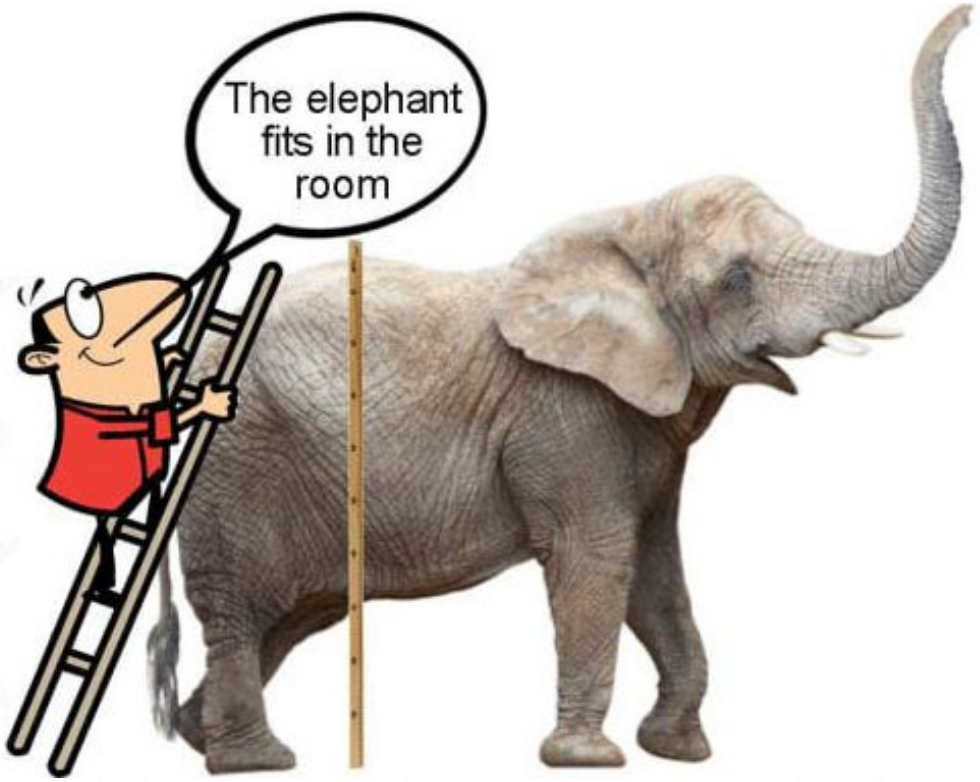
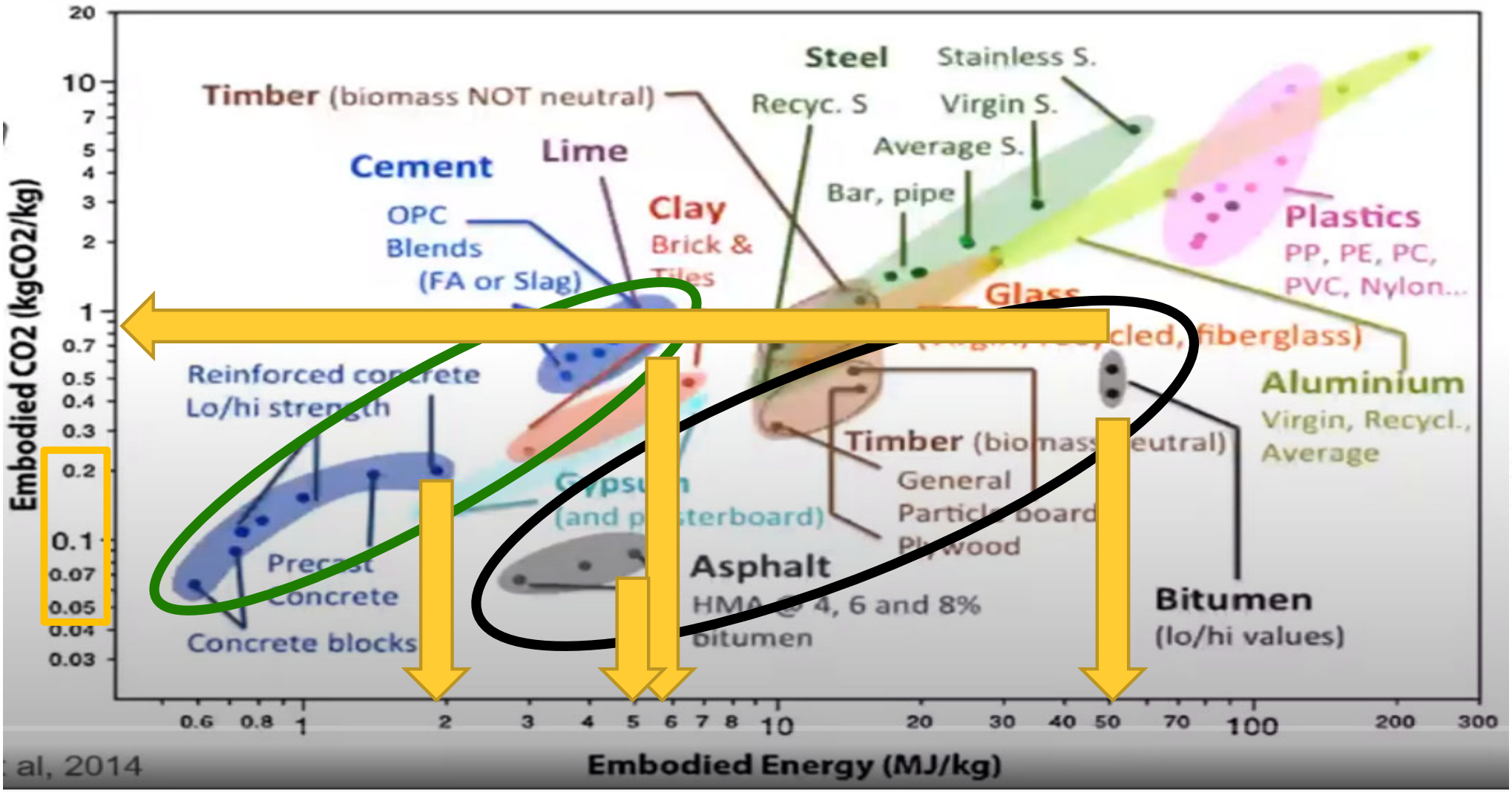
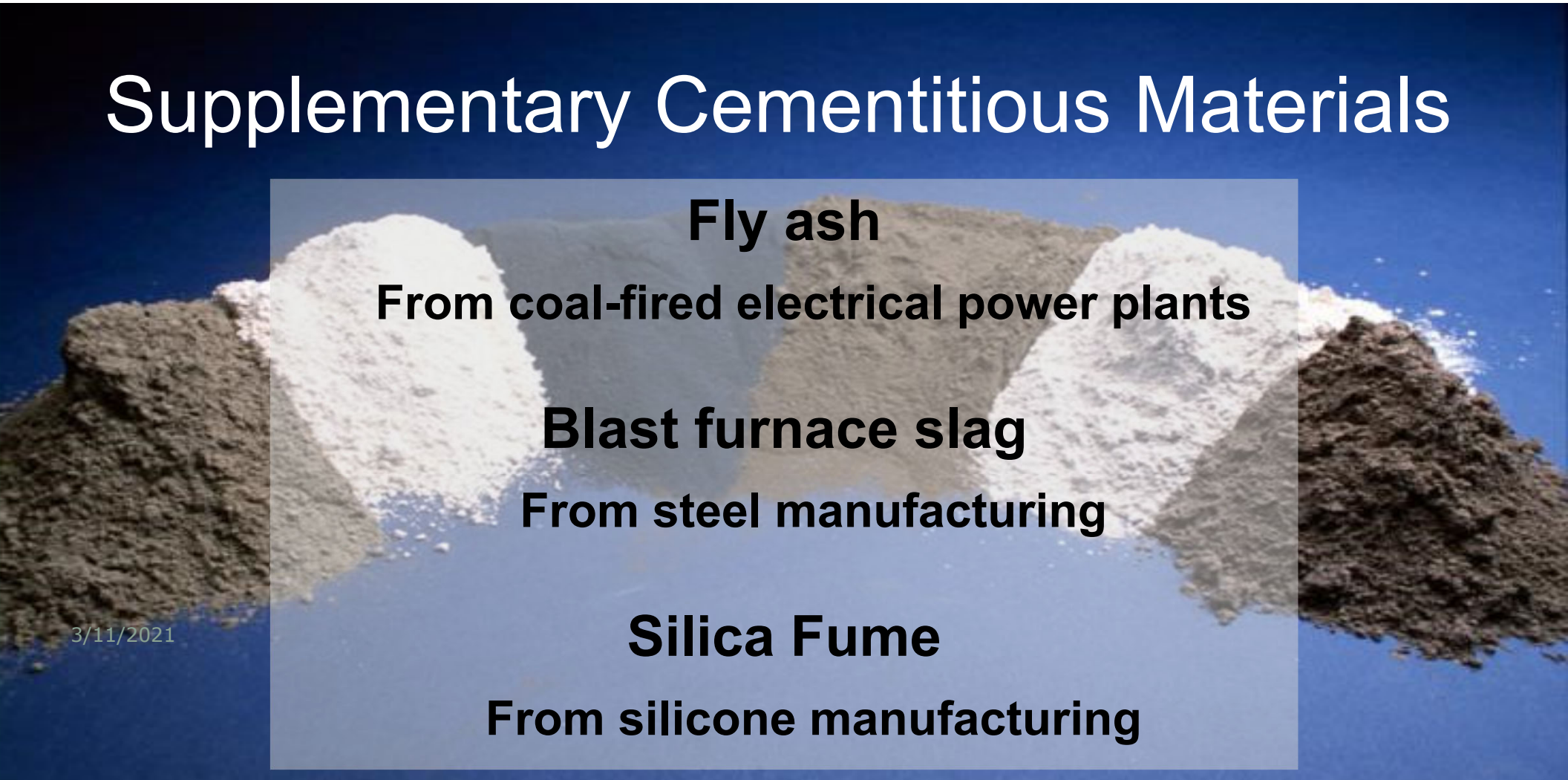


Lowering Concrete's Carbon Footprint


Embodied CO2 (kgCO2/kg)
20
10
7
5
4
3
2
1
0.7
0.5
0.4
0.3
0.2
0.1
0.07
0.05
0.04
0.03
Timber (biomass NOT neutral)
Steel
Recyc. S
Stainless S.
Virgin S.
Average S.
Bar, pipe
Cement
Lime
Clay
Brick &
Tiles
OPC
Blends
(FA or Slag)
Plastics
PP, PE, PC,
PVC, Nylon...
Glass
cled, fiberglass)
Aluminium
Virgin, Recycl.,
Average
Reinforced concrete
Lo/hi strength
Timber (bio ass eutral)
General
Particle board
Plywood
Gypsu
(and p sterboard)
Precast
Concrete
Concrete blocks
Asphalt
HMA @ 4, 6 and 8%
bitumen
Bitumen
(lo/hi values)
0.6
0.8
1
2
3
4
5
6
7
8
10
20
30
40
50
70
100
200
300
Embodied Energy (MJ/kg)
al, 2014

Supplementary Cementitious Materials



Fly ash

From coal-fired electrical power plants

Blast furnace slag

From steel manufacturing

Silica Fume

From silicone manufacturing

Cement

- **Alternative fuels**
- **Energy efficiency**
- **Clinker replacement**
- Cement formulation
- Carbon sequestration at cement plant
- Carbon sequestration in cement production

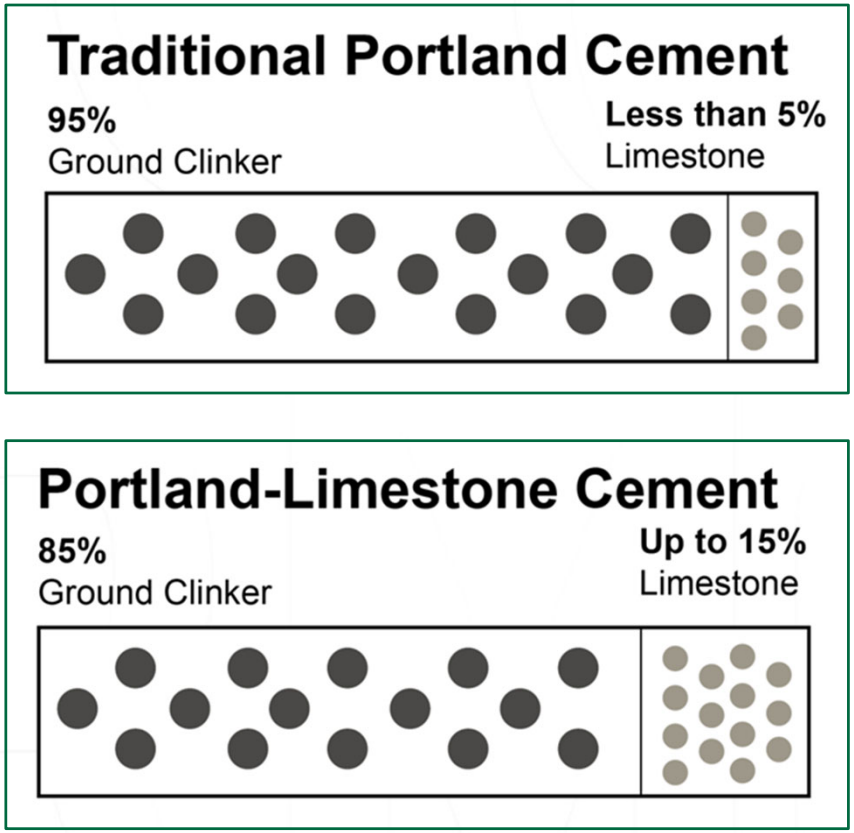
Concrete

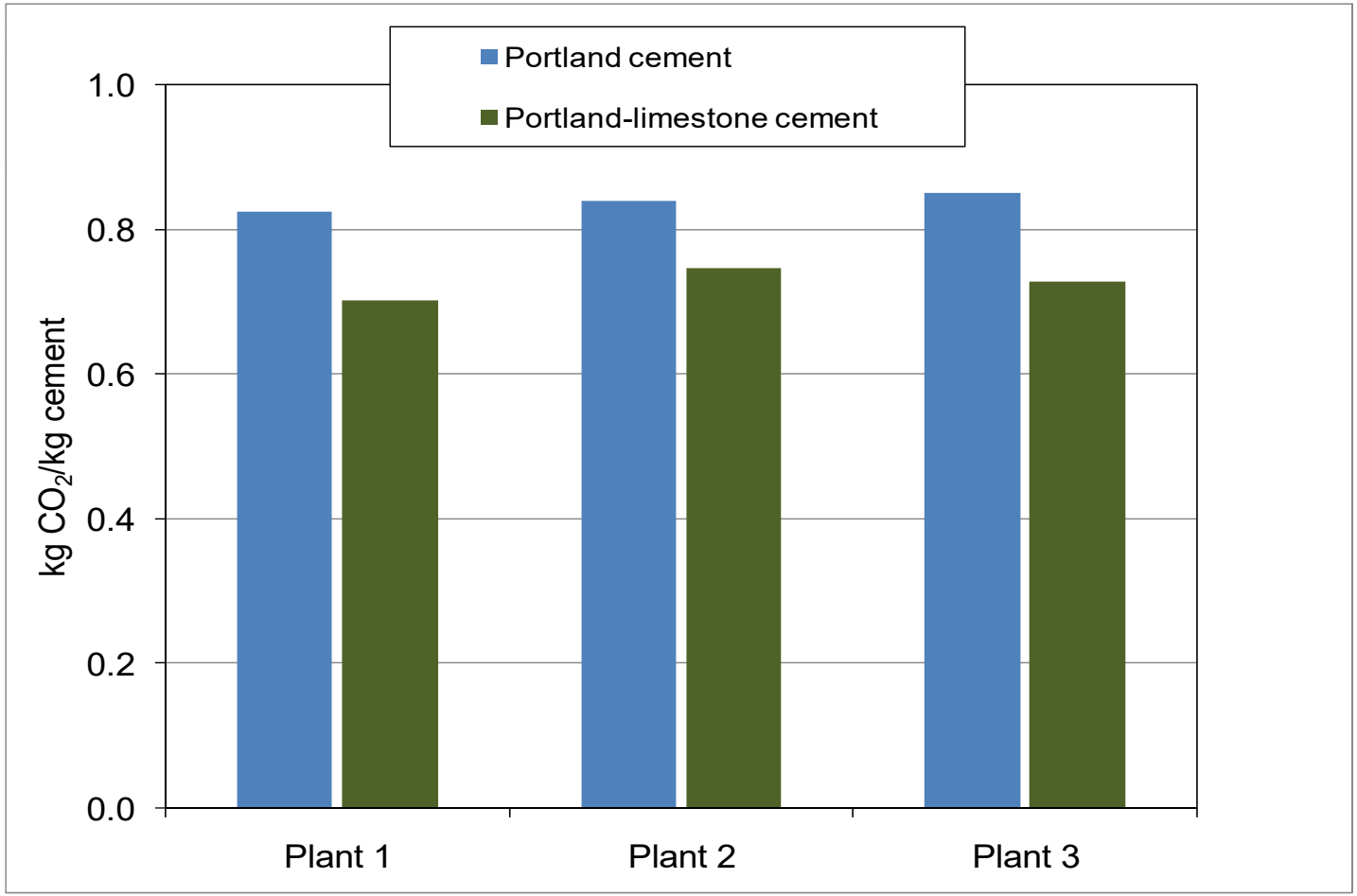
- **Cement replacement**
- Carbon sequestration in concrete production
- Carbon sequestration in aggregate production

A greener cement option

PORTLAND-LIMESTONE CEMENT (PLC)

What is Portland-limestone cement?





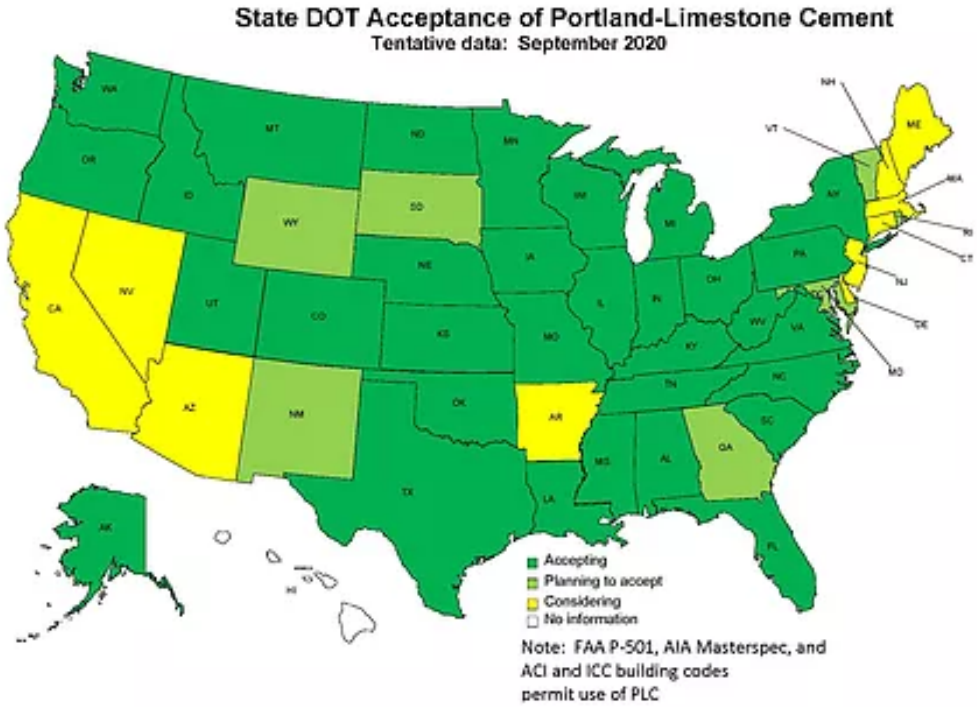
Schmidt 1992

History of PLC Acceptance/Use

Europe – 50+ years

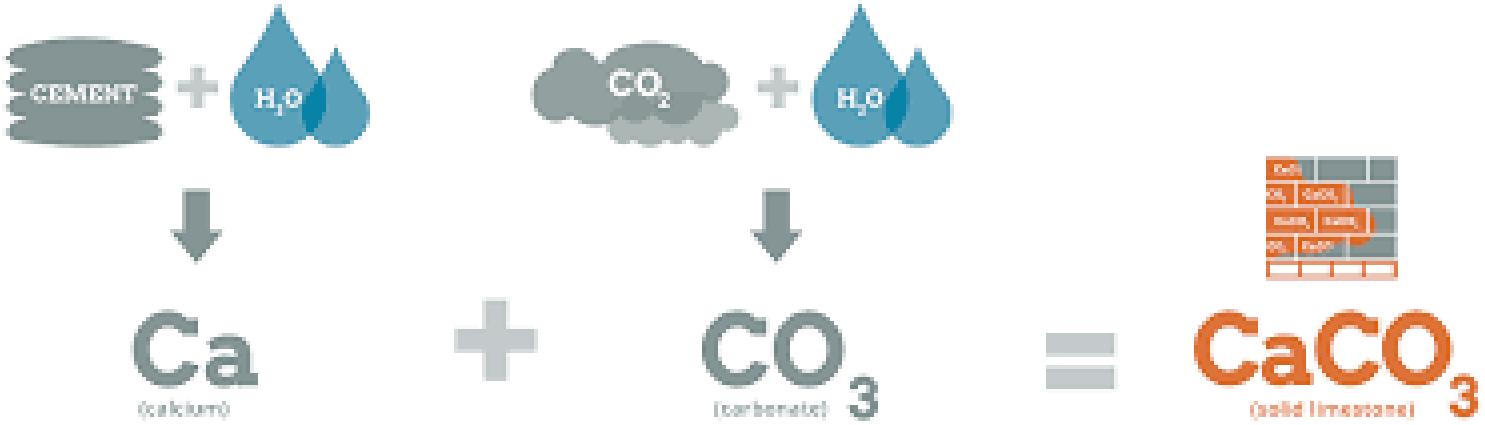
Canada – 10+ years

USA – Growing in acceptance



greenercement.org

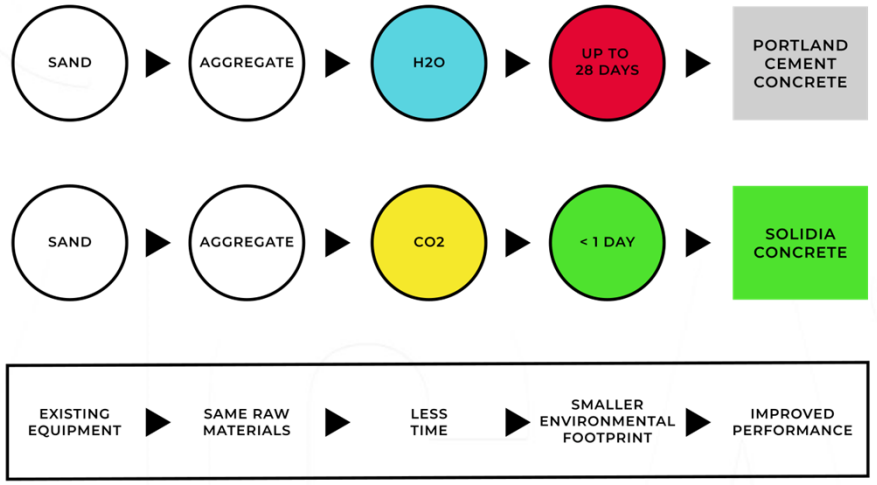
Enhanced Carbonation



Courtesy of CarbonCure

Enhanced Carbonation - Cement

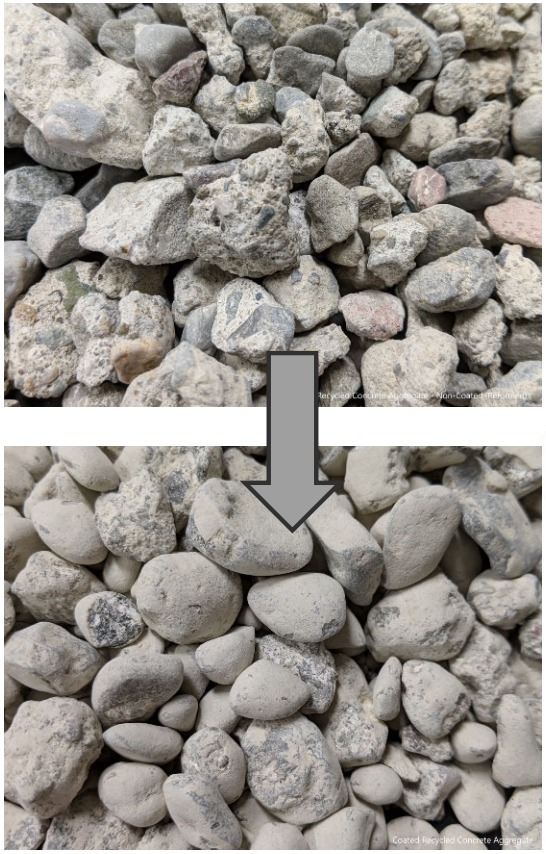
- Specially formulated cement
- Significantly reduces CO_2 emissions through reduced production energy
- Uses less limestone, fired at lower temperatures
- Produces 30% less greenhouse gases
- Sequesters CO_2 equal to 5% of its weight
- Research shows concrete's carbon footprint is reduced by 70%.
- About the same cost as Portland cement
- Primarily in the precast concrete products industry



Courtesy Solidia Technologies™

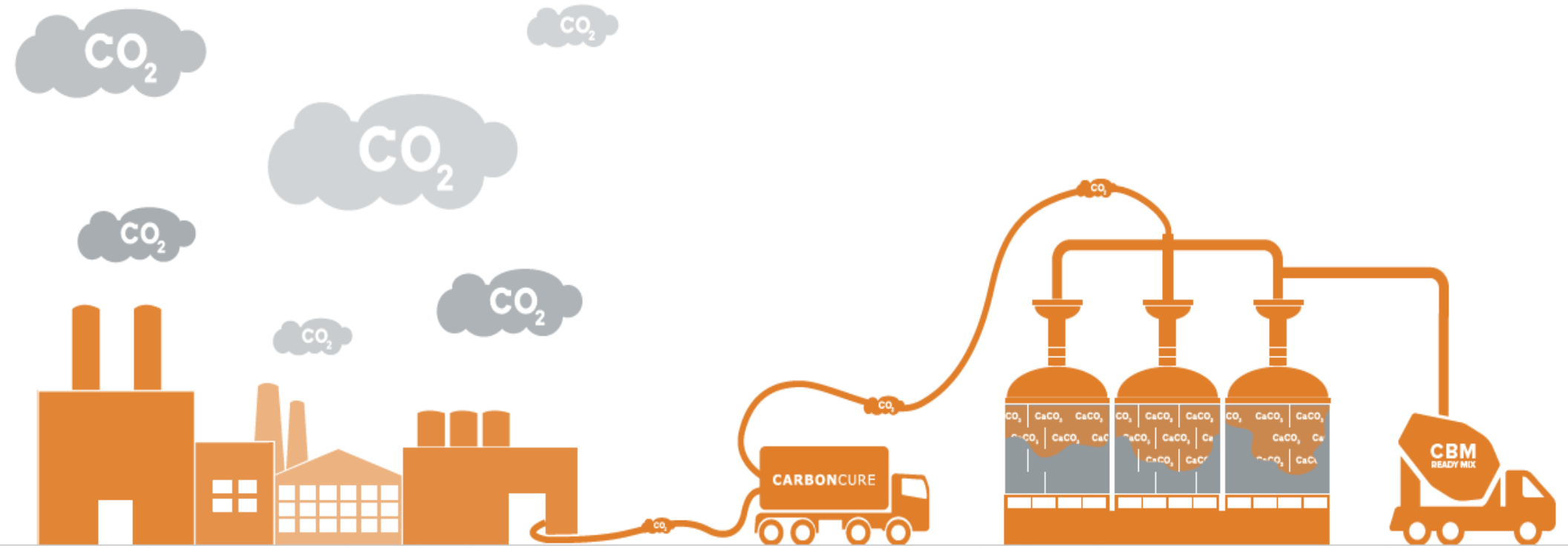
Enhanced Carbonation - Aggregate

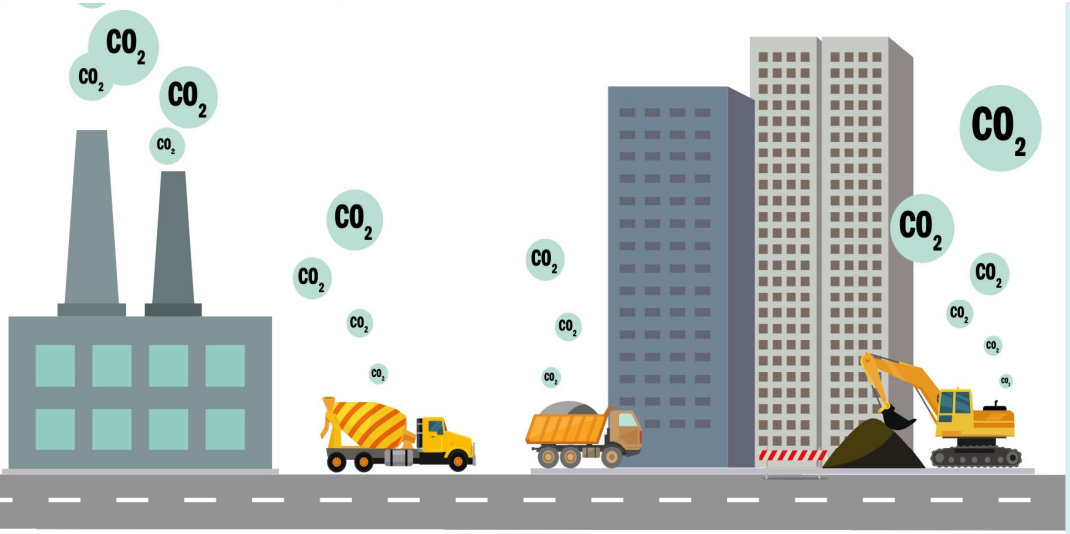
- Combines industrial CO_2 emissions with metal oxides
- CO_2 sequestered construction aggregate (limestone)
- 44% by mass permanently sequestered CO_2
- Substrate is small rock particles or recycled concrete
- Carbon-negative concrete is achievable
  - One cubic yard of concrete contains 3,000 pounds of aggregate
  - 44% comprised of sequestered CO_2, roughly 1,320 pounds
  - Offsets more than the amount of CO_2 produced by cement
  - Roughly 600 pounds per cubic yard



Courtesy of Blue Planet™

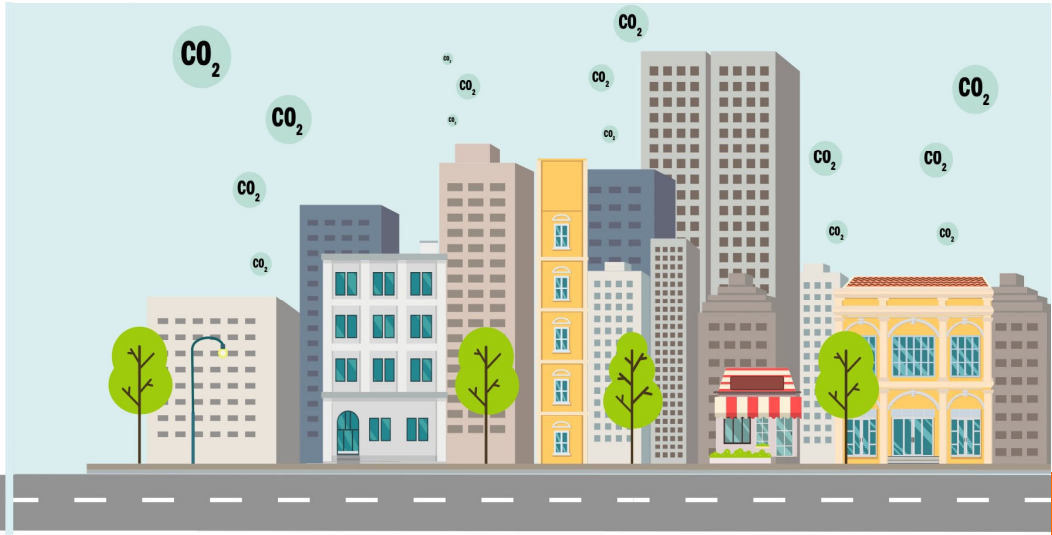
Enhanced Carbonation - Concrete





Embodied Carbon

The emissions of carbon dioxide outside the operation or in-use phase of a building, including material extraction, transport, construction, renovation, and demolition/disassembly.



Operational Carbon

The emissions of carbon dioxide (CO_2) during the operation or in-use phase of the building.

Materials

Technology

Transportation

Energy

Design

Additional CO^2 Savings

CARBON CURE™

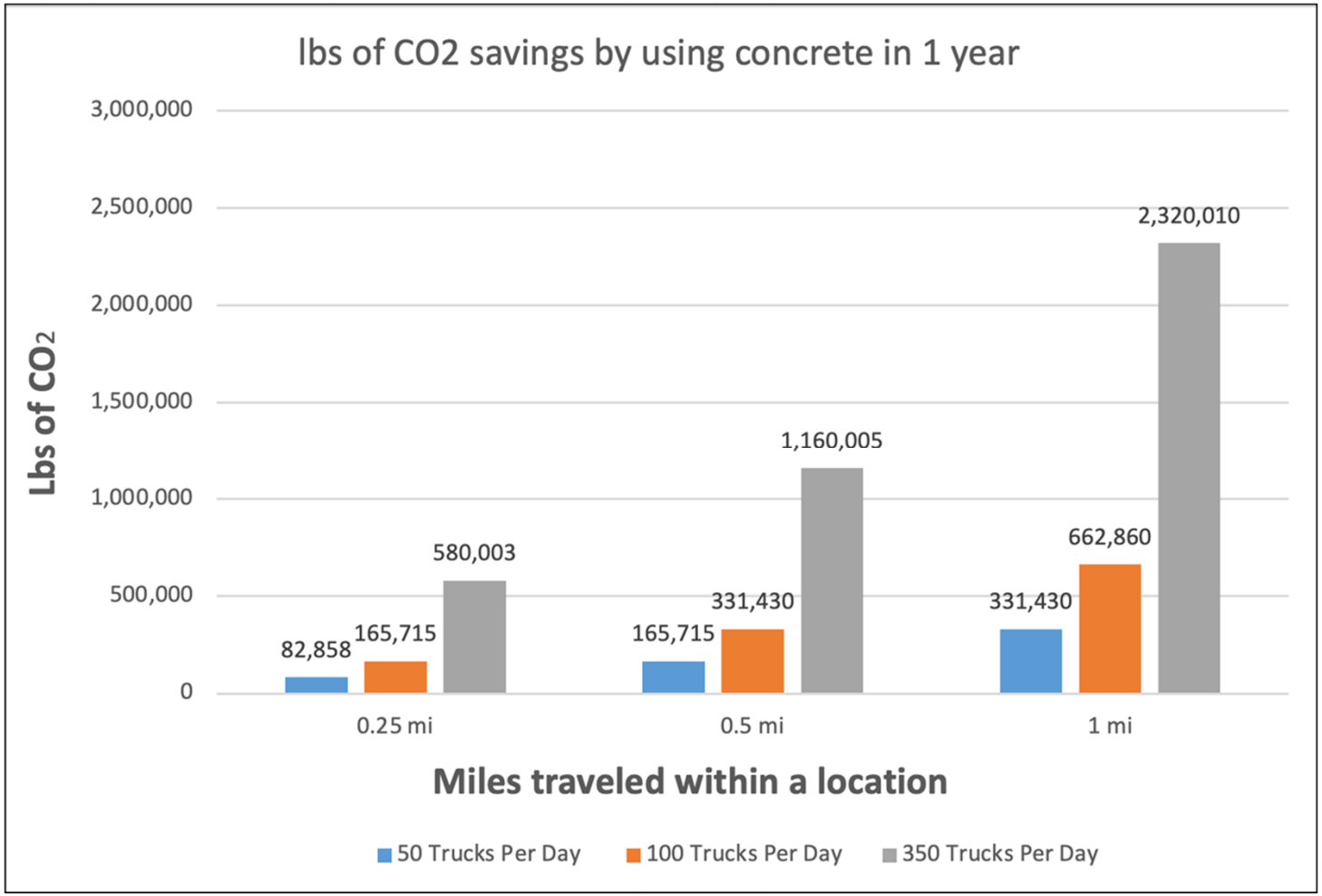
20-35 lbs CO^2 savings per yd^3

Saving on Carbon Emissions with Concrete

Assuming a 1:1 relationship between Cement and CO2 savings

1. Use of SCMs (fly ash and slag)	up to 80% cement reduction
2. CarbonCure	up to 7%
3. Admixtures	up to 8%
4. Portland Limestone Cement (PLC)	additional 10%
5. Fuel Savings	see next slide

CARBON CURE™

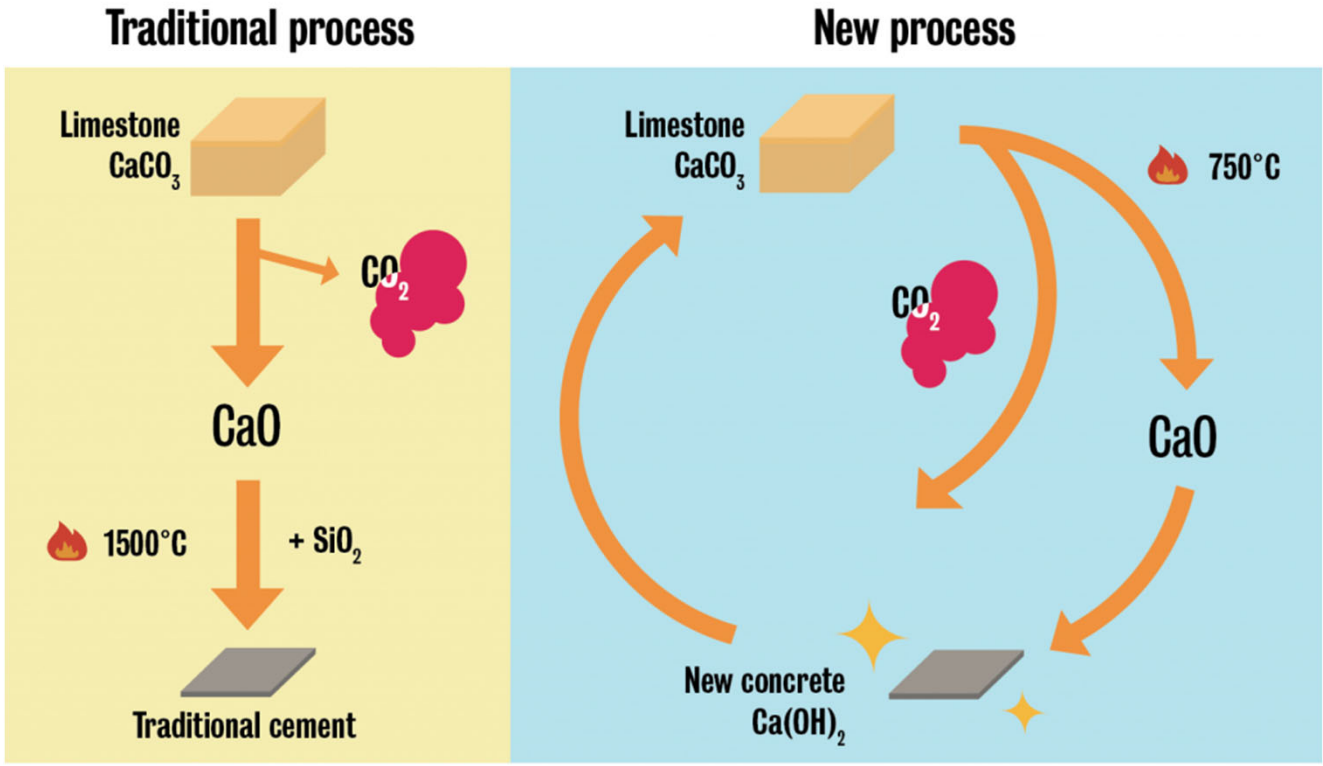


savings based on assumed 262 working days in the year

sources: EPA & MIT

Carbon Capture - CO_2NCRETE™

- UCLA
- Carbon Upcycling
- Produces CO_2 neutral cement



SOURCE: Gaurav Sant, civil and environmental engineering associate professor. Graphic reporting by Xinchen Li, Daily Bruin contributor. Graphic by LeAnn Woo, Graphics editor.

Common prescriptive requirements	Occurrence in Specifications
Restriction on SCM quantity	85%
Maximum water-cement ratio	73%
Minimum cementitious content for floors	46%
Restriction on SCM type, characteristics	27%
Restriction on aggregate grading	25%

Source: Obla & Lobo, NRMCA, 2015

Design multiple concrete mixtures that meet performance specifications

Mixture	Cost	Env. Impact
A	Low	High
B	Moderate	Moderate
C	High	Low

Source: Obla & Lobo, NRMCA, 2015

Transitioning to performance-based specifications requires collaboration to share planning and risk among all participants

- Architects
- Engineers
- Specifiers
- Constructors
- Developers
- DOT's

MIT CONCRETE SUSTAINABILITY HUB

- Life-Cycle Thinking
- Innovation
- Fiscal Responsibility
- Environmental Leadership

Research

- Conduct research to support benefits of concrete

Tools

- Develop tools to support infrastructure decisions: life-cycle, cost, and hazard resistance

Using a *holistic* approach, develop breakthroughs that will achieve durable and sustainable:

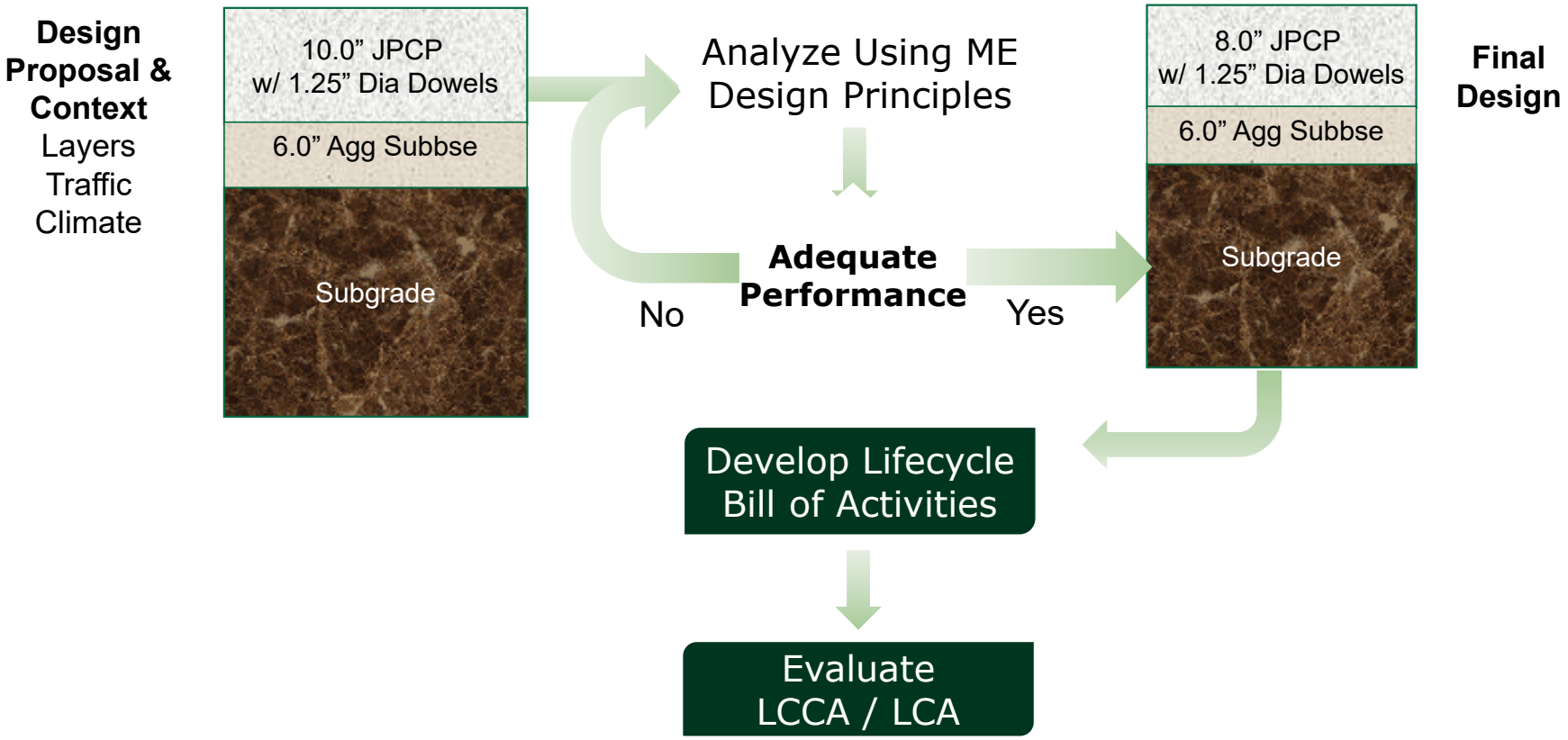
- homes,
- buildings, and
- Infrastructure

in ever more demanding environments.

Incorporating "Green" Elements

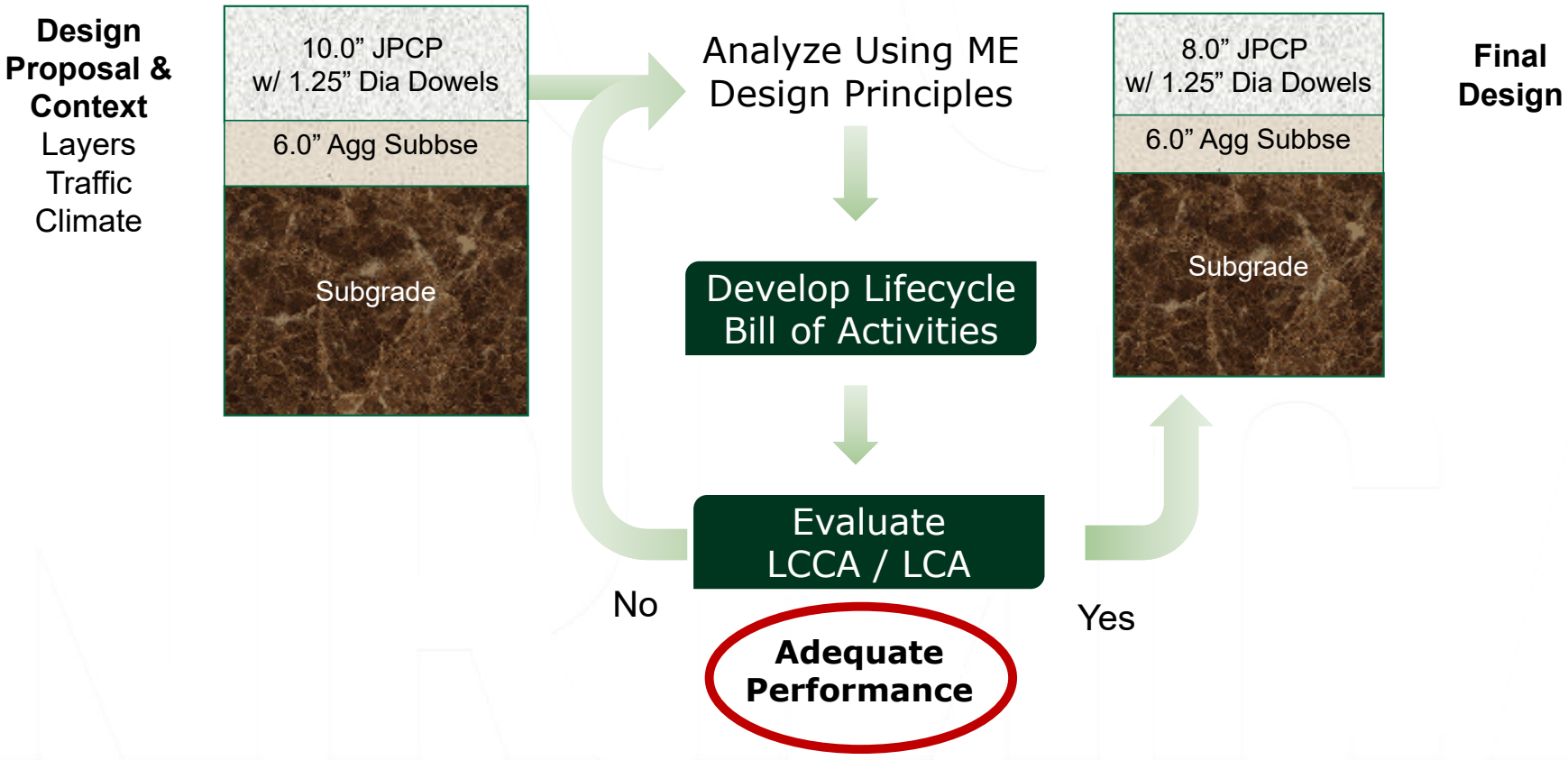
SUSTAINABILITY: LOW IMPACT/ RESILIENT DESIGNS

Pavement design should be iterative

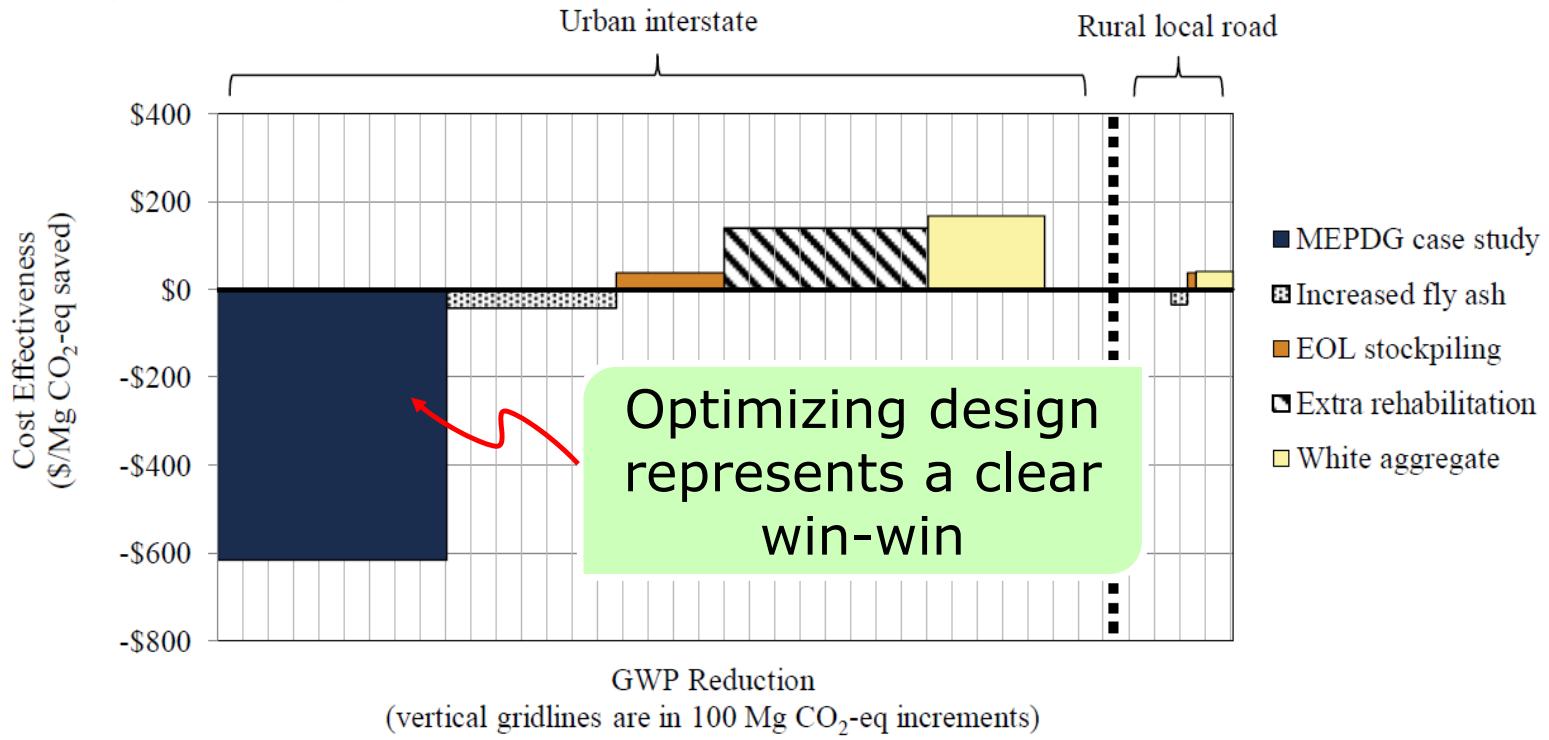


Pavement design should be iterative

Accelerated feedback → more analyses, more improvement, better sustainability



Pavement design optimization saves GHG's & $



Incorporating "Green" Elements

SUSTAINABILITY: LOW IMPACT USE PHASE


41
Tamiami Trail
EXIT 3/4 MILE
968
Flagler St.
1/4 MILE
EXIT ONLY

BUILD WITH STRENGTH

www.nrmca.org | National Ready Mixed Concrete Association | #nrmca

PAVE AHEAD

DURABLE. SUSTAINABLE. CONCRETE.

Model Scenarios

High volume road:

65 mph highway

3 lanes each direction

4 shoulders

Daily traffic: 139,000

(Of which trucks: 6,672)

Moderate volume road:

35 mph urban road

2 lanes in each direction

4 shoulders

Daily traffic: 23,400

(Of which trucks: 1,357)

Low volume road:

35 mph rural road

1 lane in each direction

No shoulder

Daily traffic: 5,200

(Of which trucks: 468)

Pavement-Vehicle Interaction (PVI)

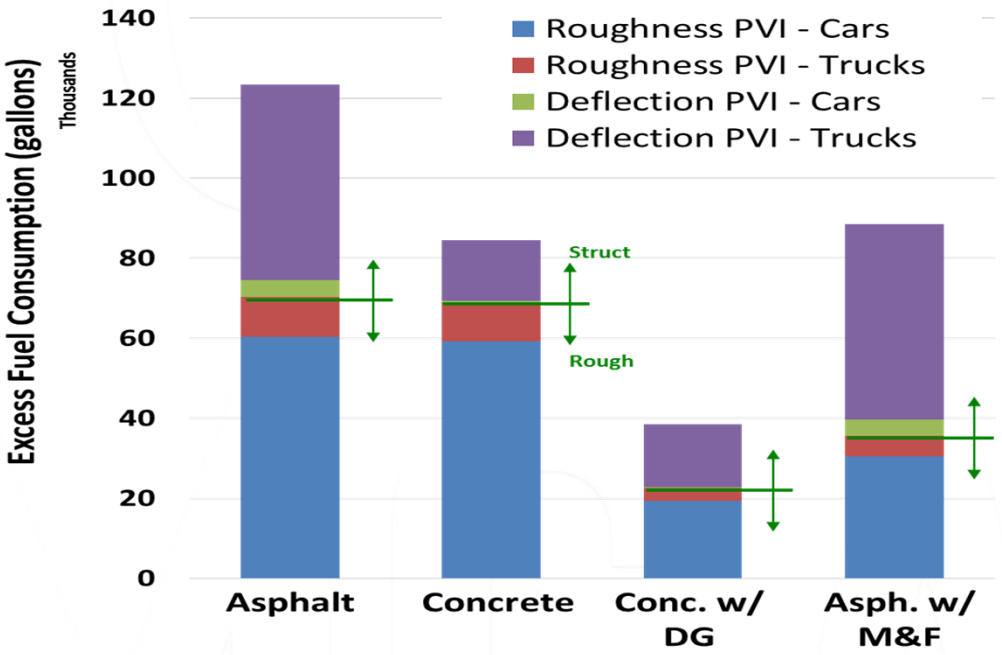
PVI - Pavement Stiffness

Deflection

Roughness

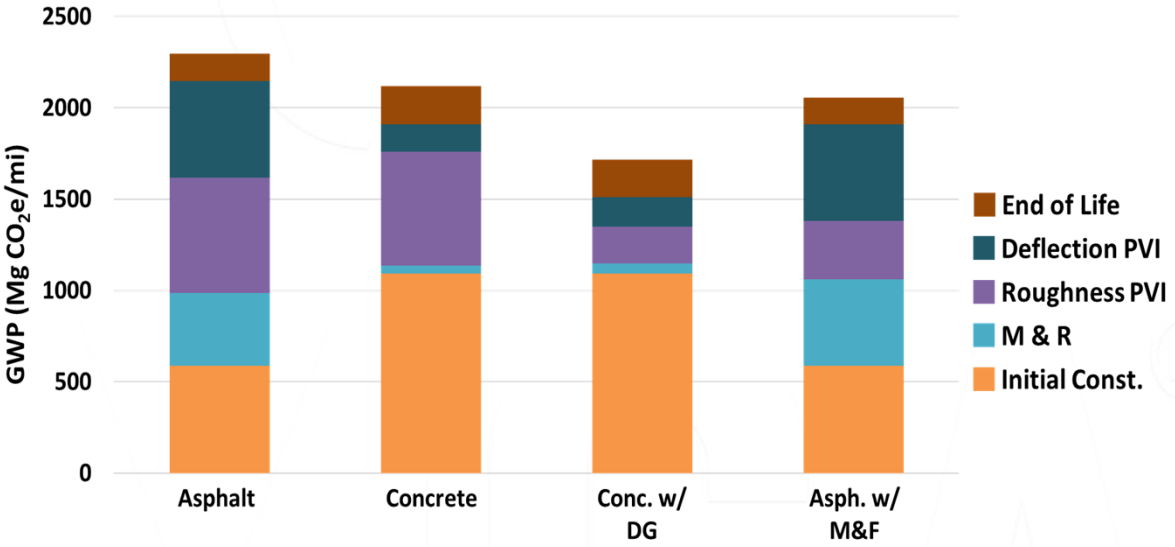
Stiffer Pavement Equals:

- 0.5 to 3% reduction in fuel consumption (trucks)



Stiffer Pavement Equals:

- 0.5 to 3% reduction in fuel consumption (trucks)
- Lower Green House Gas Emissions



Stiffer Pavement Equals:

- 0.5 to 3% reduction in fuel consumption (trucks)
- Lower Green House Gas Emissions
- Lower User Costs

In Summary…

Sustainability affected at different stages:

- Materials selection
- Design
- Asset management
- Use-Phase

Various ways to disclose/quantify

- Method chosen is dependent on desired outcome

4. 3 Part Series: Part 2 - Portland Limestone Cement: 'Equivalent' Performance to Type I/II with a Smaller Carbon Footprint

March 17th 2021

2. How to Design Industrial and Light Duty Parking Lot Asphalt Pavements

RESCHEDULED FOR MARCH 25th, 2021

Mike Harrell, Principal Engineer, Applied Research Associates and Mike Ward, Operations Manager, Rabine Paving Group

5. 3 Part Series: Part 3 - How Specifying Carbon Cure in Your Parking lot Concrete Can Lower CO2 Emissions

April 7th 2021

Allison Palmer, Market Development Manager, CarbonCure Technologies and Ryan Cialdella, Vice President of Customer Development, Ozinga

Read More

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