

# NIST Low Carbon Cements and Concretes Consortium

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ACI Concrete Convention, Philadelphia, PA  
Impact of Buy Clean and Low-Carbon Policies on the Sustainability of Concrete  
Sunday, November 3, 2024



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Discuss standards and innovation

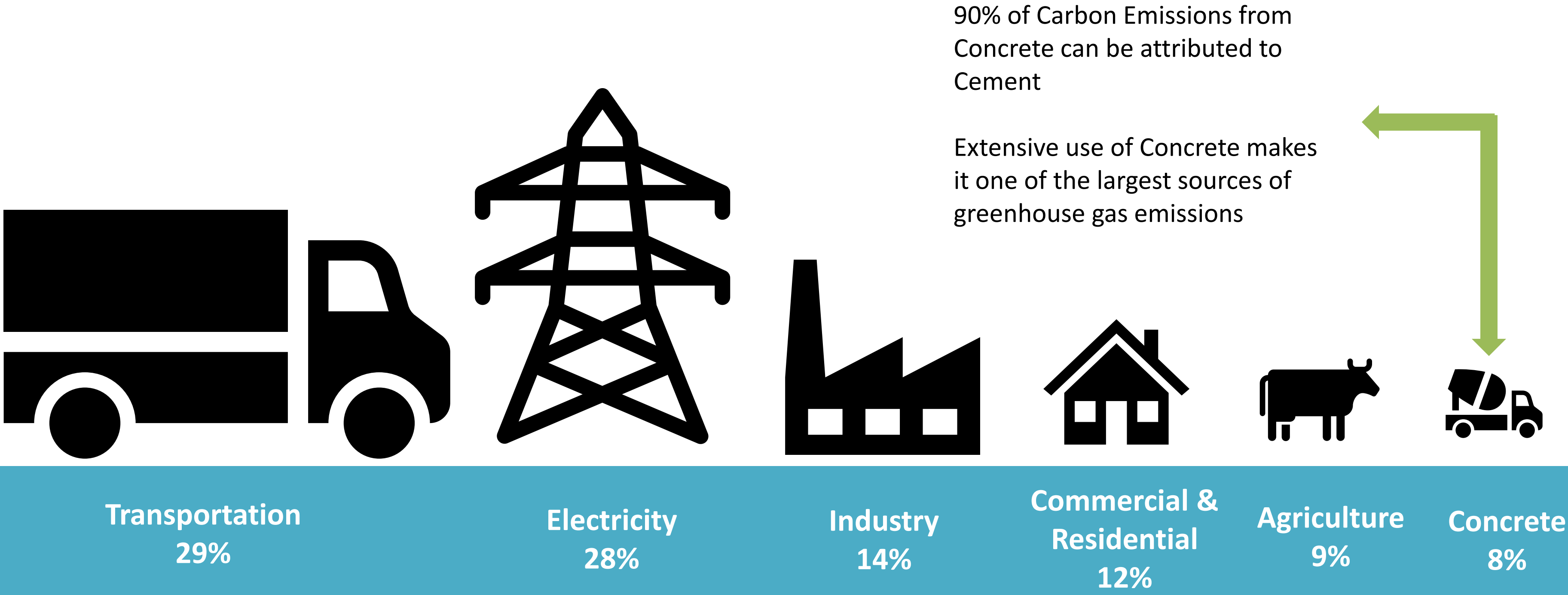
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Describe NIST's role in measurement and standards

3

Describe NIST's Low Carbon Cements and Concretes Consortia

# Concrete and Carbon Emissions



Source: Keegan. "Cement and Concrete: The Environmental Impact- PSCI." *Princeton University*, Princeton Student Climate Initiative, 3 Nov. 2020, [psci.princeton.edu/tips/2020/11/3/cement-and-concrete-the-environmental-impact](https://psci.princeton.edu/tips/2020/11/3/cement-and-concrete-the-environmental-impact)

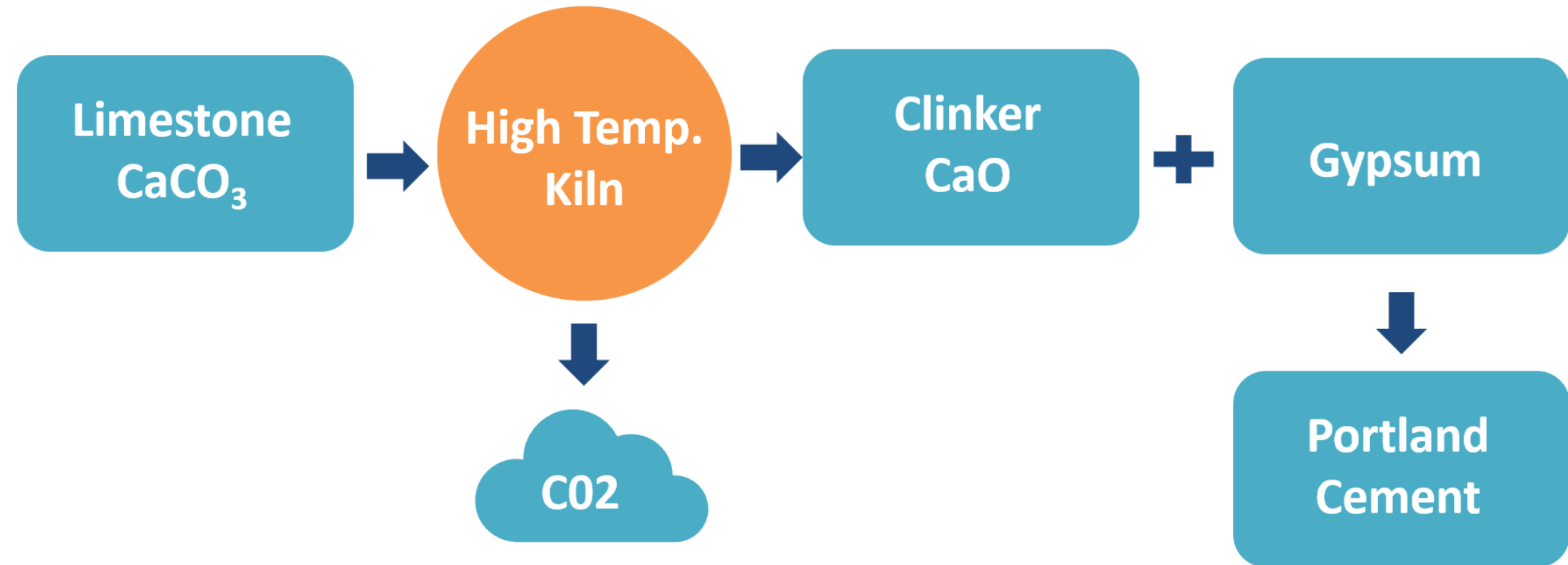
# How does cement production emit CO2?

**50%**  
Chemical reaction that occurs during the production of clinker.

**40%**  
Burning of fossil fuels to heat the kilns that make clinker.

**10%**  
Material sourcing and transport.

## Traditional Portland Cement Production



Source: IOP Publishing. (n.d.). Perspectives on environmental CO<sub>2</sub> emission and energy factor in Cement Industry. IOPscience. <https://iopscience.iop.org/article/10.1088/1755-1315/331/1/012035>

# Opportunities to Reduce Concrete's Carbon Footprint



## Optimized Manufacturing



- Alternative Energy Sources
- Increased Kiln Efficiency

## Alternative Methods of Clinker Production



- Limestone Alternatives (calcium silicates, magnesium silicates)

## Reduced Use of Clinker in Cement Production



- Portland Limestone Cement (Type 1L)

## Reduced Portland Cement Content in Concrete



- Supplementary Cementitious Materials (SCMs)
- Optimized Aggregate Grading
- Optimize Performance

## Efficient Design Structural Design



- Avoid Overdesign
- UHPC

## Carbon Capture, Utilization, and Storage



- Capture CO<sub>2</sub> from production
- CO<sub>2</sub> Concrete Curing
- Mineral Carbonation
- Recarbonation

# Measurement Challenges

Carbonate  
Content

Rate of  
Recarbonation

Durability &  
Performance

Effectiveness  
of Carbon  
Capture

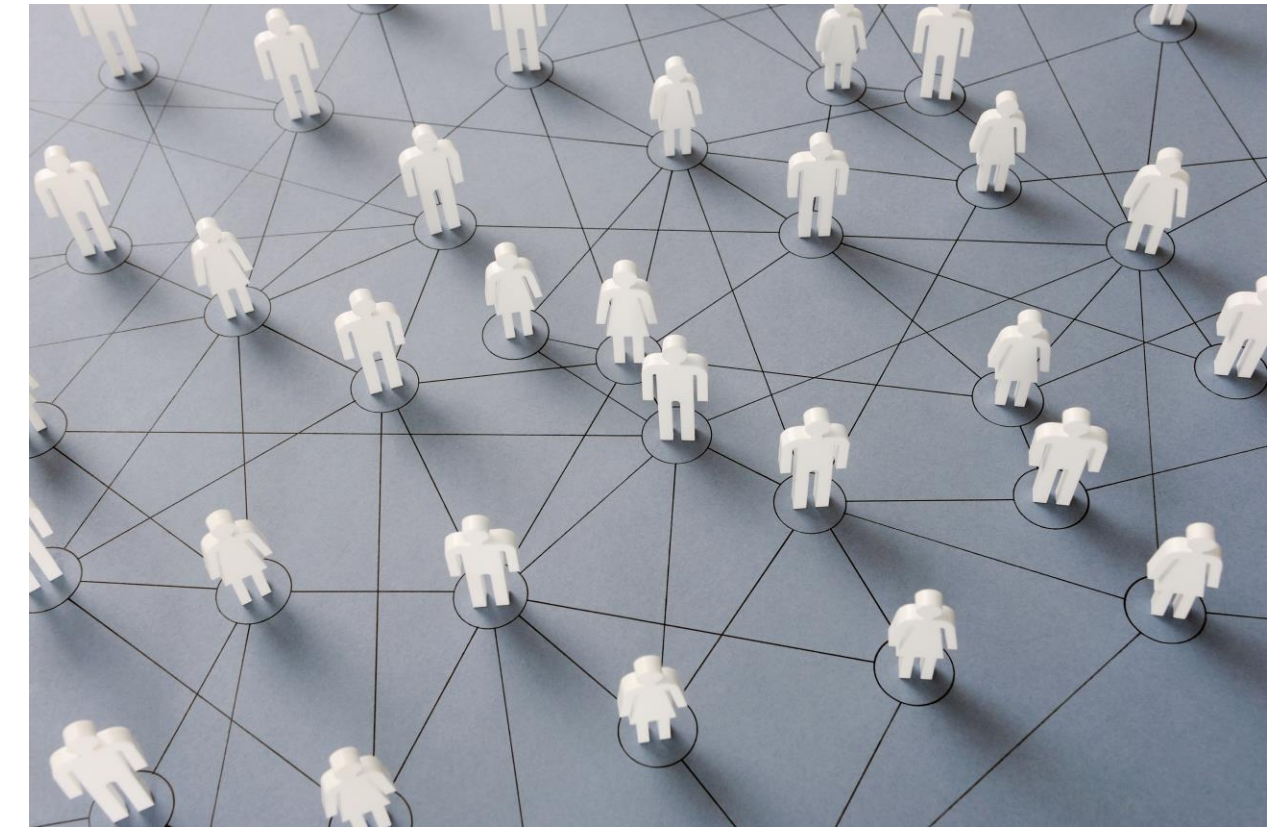
Environmental  
Product  
Declarations  
(EPDs)

Life Cycle Cost  
Analysis (LCA)

Scalability

*Innovation* occurs when a new, different, and valuable product has been made available to potential users.

Participation in *standards development* can help companies innovate through increased engagement with stakeholders and competitors.



## Functions of Standards

- *Codifying Knowledge* – consensus-based development of authoritative rules
- *Reducing Variety* – prescribed specifications to enable economies of scale
- *Securing Quality* – specified performance levels (e.g., health, safety, environment)
- *Achieving Compatibility* – compatibility and interoperability

**Support Emergence  
and Growth of New  
Technologies**



**Enhance Confidence  
in the Quality and  
Reliability of Low  
Carbon Cements  
and Concretes**

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**Accelerate market  
adoption**

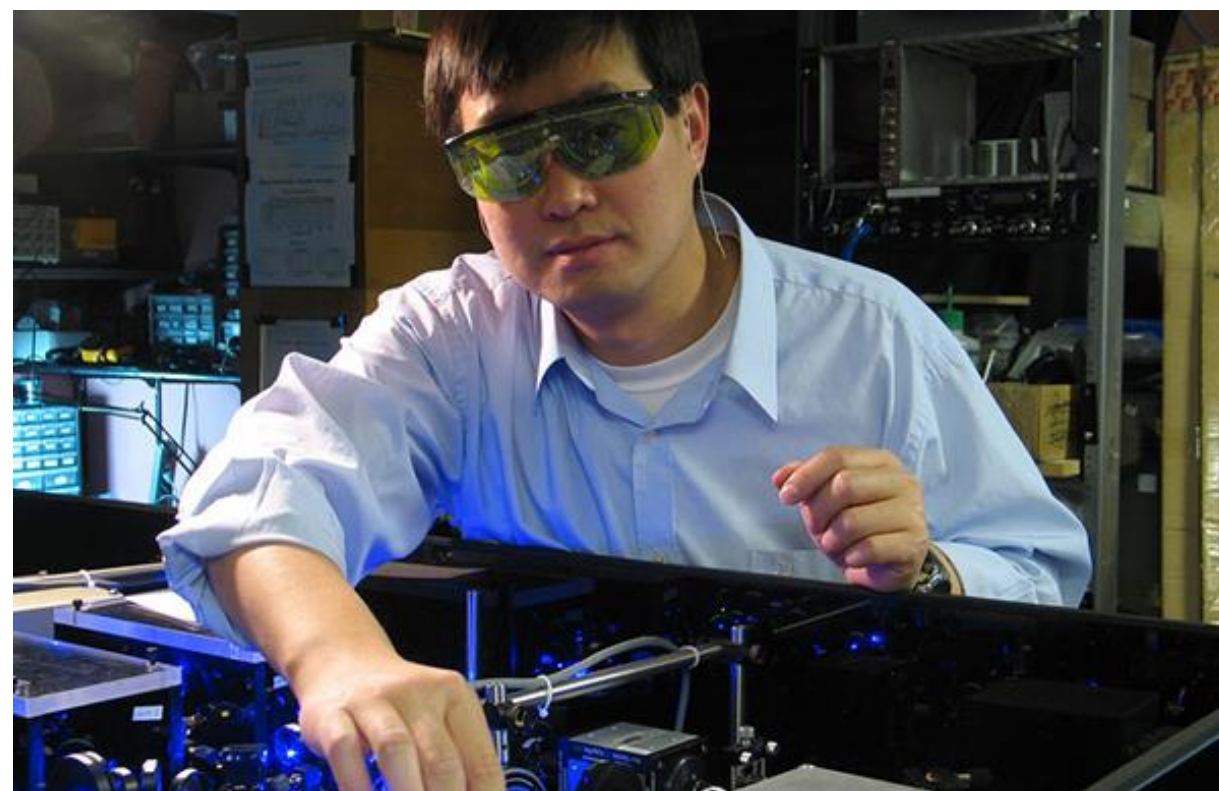
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# NIST Mission



To promote U.S. innovation and industrial competitiveness by advancing **measurement science**, **standards**, and **technology** in ways that enhance economic security and improve our quality of life



# NIST AT A GLANCE

## Industry's National Laboratory



**3,400+**

FEDERAL  
EMPLOYEES



**5**

NOBEL PRIZES



**2 Main Campuses**

GAITHERSBURG, MD [HQ]  
BOULDER, CO



**3,500+**

ASSOCIATES



**10**

COLLABORATIVE  
INSTITUTES



**Thousands**

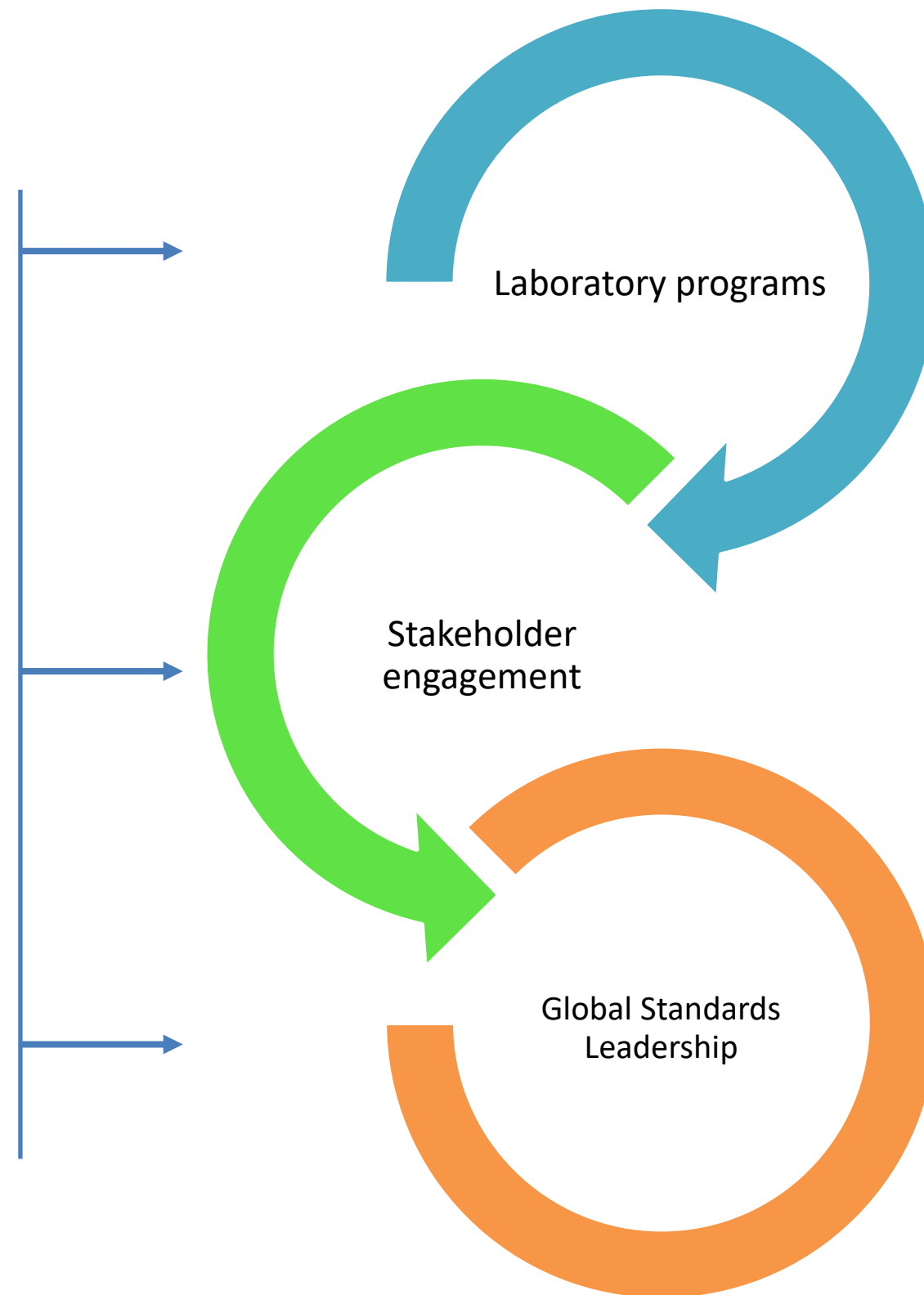
of U.S. BUSINESSES  
Collaborate with NIST

# From Laboratory Programs to Standards

NIST Core Laboratory Capabilities

Consortia & CRADA partners, USG, NMIs, NGOs & other strategic partnerships

SDOs: ISO, IEC, OECD, WHO, ASTM, PDA, etc. Professional societies



- In house capabilities & expertise to support the rapidly evolving technology
- Pre-competitive technology, measurement solutions, reference materials and ref. data, etc.
- Ongoing bilateral collaborations with NMIs
- Support innovation and commerce
- Support global regulatory convergence

# NIST Measurement Services Support the Global Measurement Infrastructure



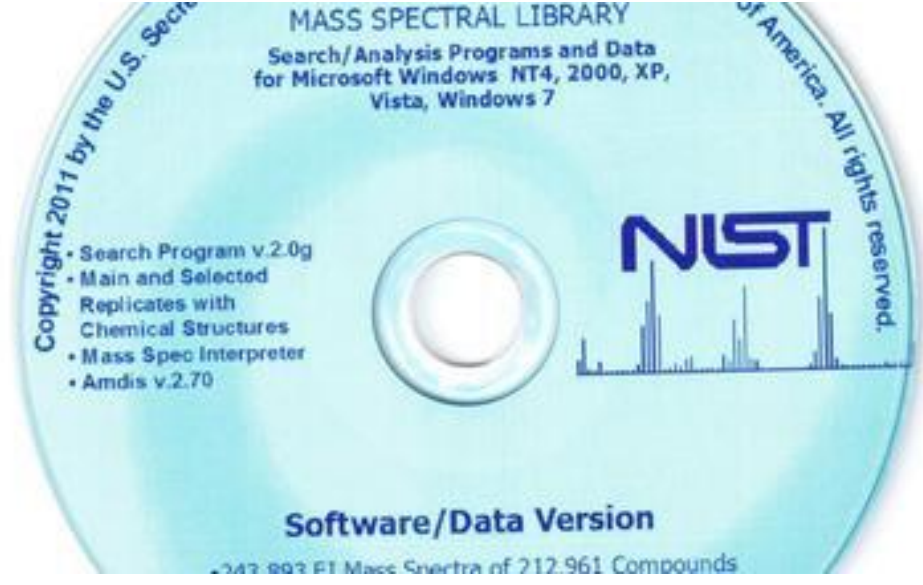
Reference Materials

Reference Data

Measurement science & technology development

Documentary Standards

Calibration Services



ISO 20391-1:2018  
Biotechnology — Cell counting — Part 1: General guidance on cell counting methods

ISO 20391-2:2019  
Biotechnology — Cell counting — Part 2: Experimental design and statistical analysis to quantify counting method performance

ISO 23033:2021  
Biotechnology — Analytical methods — General requirements and considerations for the testing and characterization of cellular therapeutic products

BUY THIS STANDARD  
FORMAT: PDF + EPUB  
LANGUAGE: English  
PAPER  
CHF 138

# Example Consortia: Public-Private Partnerships to Address Pre-competitive Challenges towards Standards Development



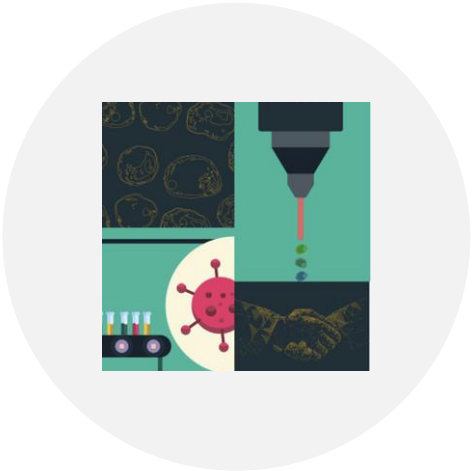
### **NIST GENOME IN A BOTTLE (GIAB) CONSORTIUM**

Provides authoritative characterization of benchmark human genomes



### **NIST GENOME EDITING CONSORTIUM\***

Develops measurement solutions and standards needed to increase confidence and reduce risk  
**Formal members: 47**



### **NIST FLOW CYTOMETRY STANDARDS CONSORTIUM\***

Accelerates the adoption of quantitative flow cytometry in biomanufacturing  
**Formal members: 33**



### **NIST RAPID MICROBIAL TESTING METHODS CONSORTIUM**

Addresses measurements and standards needed to increase confidence in the use of rapid testing  
**Formal members: 44**

**Working to expand and integrate into an Alliance**

# Low Carbon Cements and Concretes Consortium



- ▷ Initiated in 2022 in Support of NIST Carbon Accounting and Decarbonization Program
- ▷ Precompetitive and CRADA-Based, Operates through In-Kind Support
- ▷ 52 Member Organizations from the Private and Private Sectors
- ▷ Steering Group, 4 Working Groups

- AIA
- Argos
- ASCC
- Ash Grove
- Biomason
- Blue Planet Systems
- Boise State Univ.
- Brimstone
- Buchi
- Building Transparency
- Bureau of Reclamation
- CalPortland Company
- CarbiCrete
- Carbon Limit
- CarbonBuilt
- CarbonCure
- CMHA
- Continental Cement
- DOE
- EPA
- FHWA
- Fortera
- Georgetown Univ.
- Georgia Tech.
- Heidelberg Materials
- Holliday Rock
- Iowa State
- Kiewit
- Kline Consulting, LLC
- MIT - Concrete Sustainability Hub
- NEU
- NETL
- NIBS
- NRMCA
- NSF
- Outside the Box Materials
- Ozinga
- PCA
- Purdue Univ.
- Spherical Block, LLC
- St Mary's Cement
- Sublime Systems
- Sutter Engineering
- U.S. Army Corp of Engineers
- UC Davis
- UCLA
- Ultra High Materials, Inc
- Univ. of Miami
- Univ. Texas at Arlington
- WAP Sustainability
- WR Meadows
- WRI

# Meeting Schedule



## Steering Group

*Twice per year and  
as needed (online)*



## Working Groups

*Once every two  
months (online)*



## Full Consortium

*ACI Spring  
Convention*

*ACI Fall  
Convention*

*Standalone Event  
(1-2 days) in July*



## Quantifying Carbonates

Identifies the measurement challenges and opportunities for quantifying carbonates in cements and concretes by:

- developing high-quality standardized measurement methods
- identifying benchmark materials
- executing ILCs of test materials

## Carbon Accounting

- identifies and address areas of need for more accurately quantifying carbon emissions and industry decision support related to low carbon materials
- provides a common set of carbon accounting and LCA - related terminology
- identifies current limitations or issues using carbon accounting and/or LCA in decision – making

## Performance Specifications

- evaluates the applicability of existing material, mechanical, structural, and durability tests for low carbon materials
- identifies and addresses gaps in current performance-based specifications
- develops definitions for terminology to promote a uniform language and efficient exchange of information

## Innovative Materials

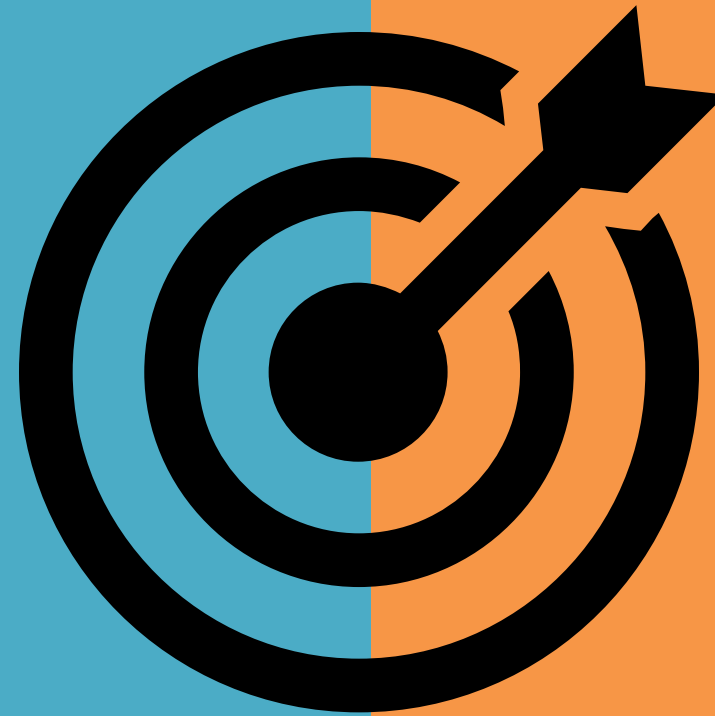
Synthesizes and disseminates information on:

- the economic, environmental, and engineering impacts of low carbon materials and implementation processes
- Evaluating the effects of low-carbon materials on concrete constructability, mechanical properties, and durability



## Accomplishments

- **Draft Test Method for Determination of CO<sub>2</sub> in Cements**- currently undergoing informal review by ASTM Subcommittee C01.23
- **Measurement Context Paper**- Written by NIST Staff and Consortium Members, characterizes the background, environment, and requirements for specific quantitative techniques to measure the carbon content of cementitious materials December Issue of Concrete International...
- **Six NIST Benchmark Materials in the final stages of preparation**



## Current Projects

- **Measuring CO<sub>2</sub> Sequestration in Hardened Concrete (Craig Walloch, CMHA)**-

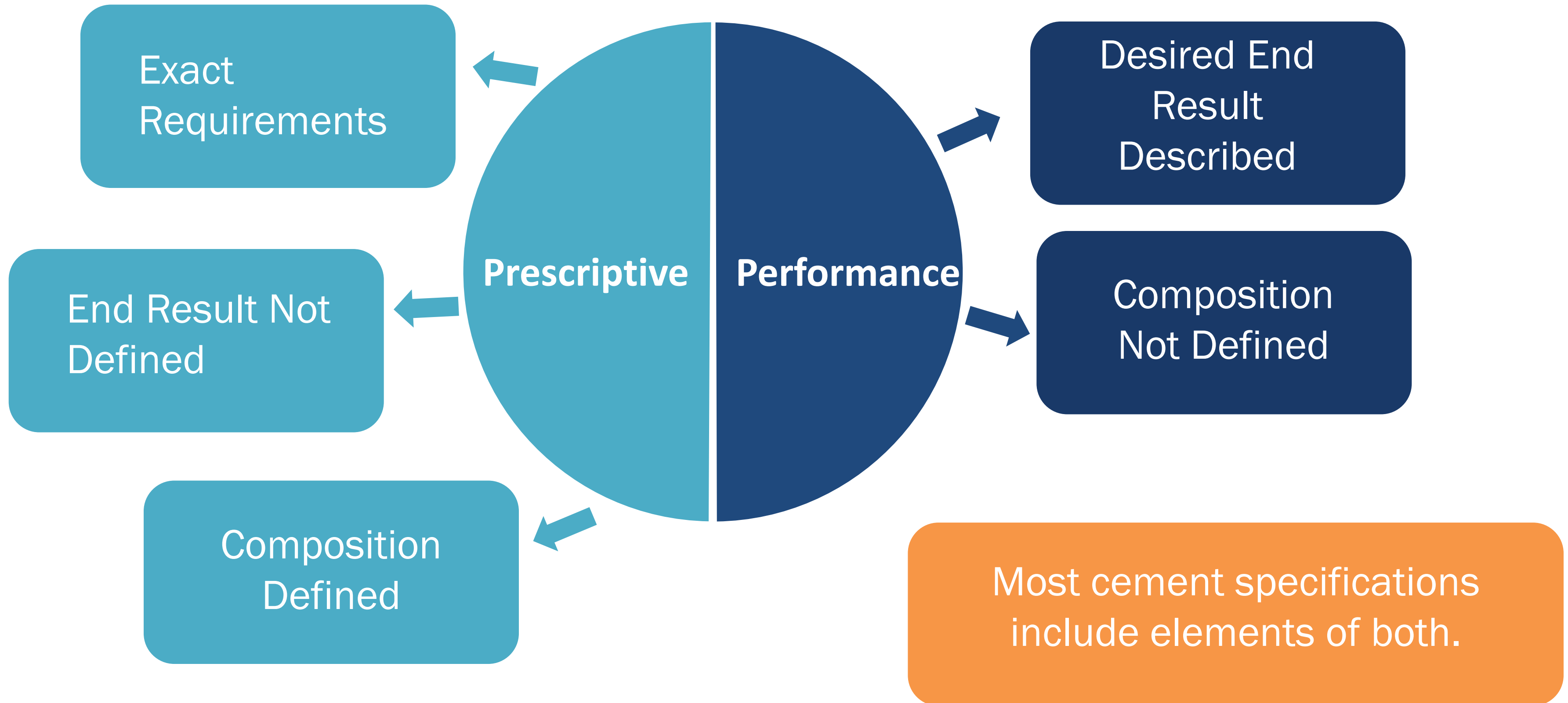
### Challenges:

- Background attributed to aggregate content is almost as large as the signal
- Measurement of systems that cure by carbonation
- Material variability
- Exposure conditions

### Activities

- Developing a guidance document describing and addressing the challenges

# Prescriptive Vs. Performance Specifications



# Performance Specifications Wish List

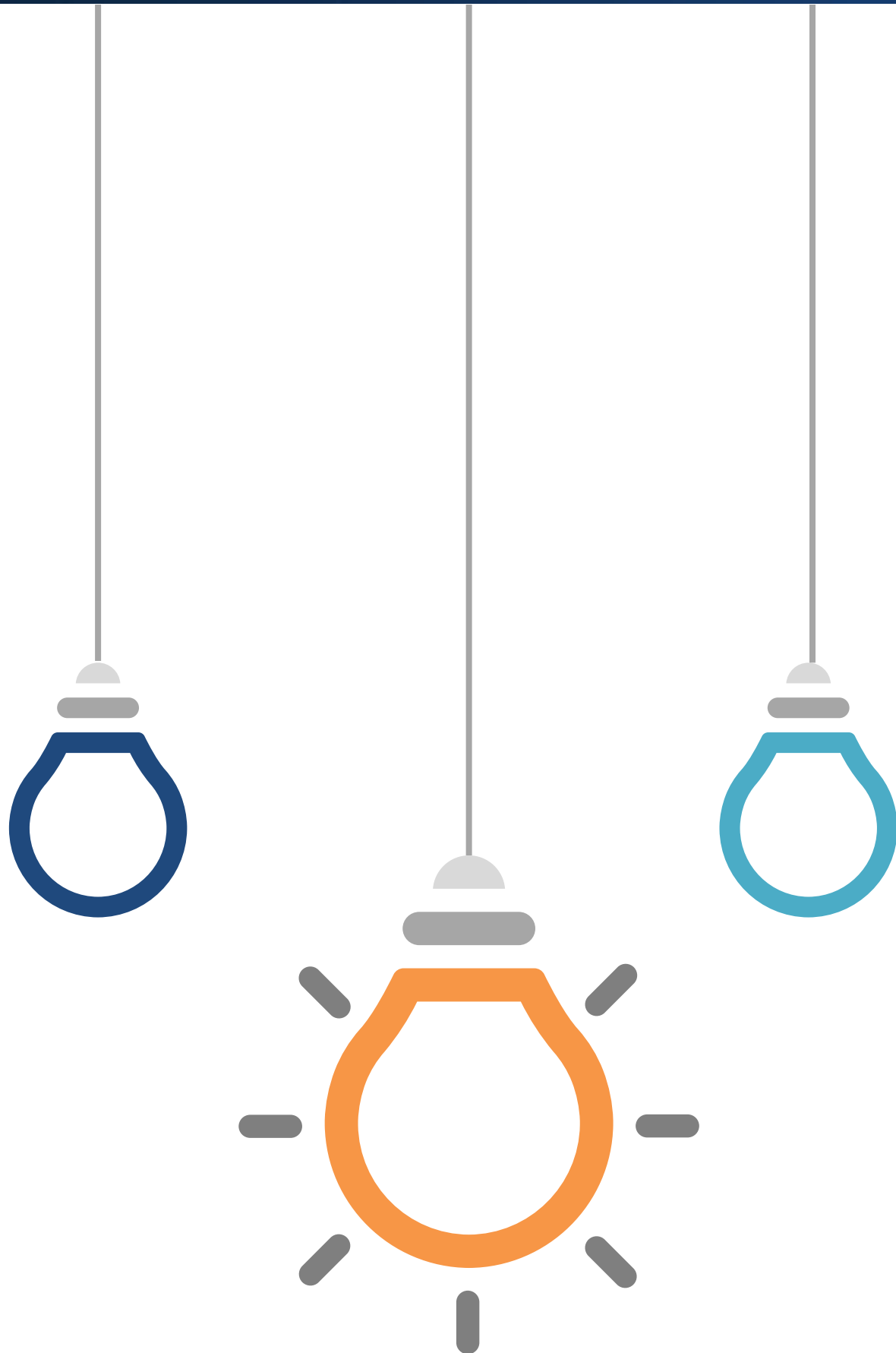
What should be included in an ideal performance-based low carbon cement specification?



Green House Gas  
Emissions  
Performance



Functional  
Performance





**A common language to facilitate communication and standardization**

**LOW CARBON  
CEMENT**

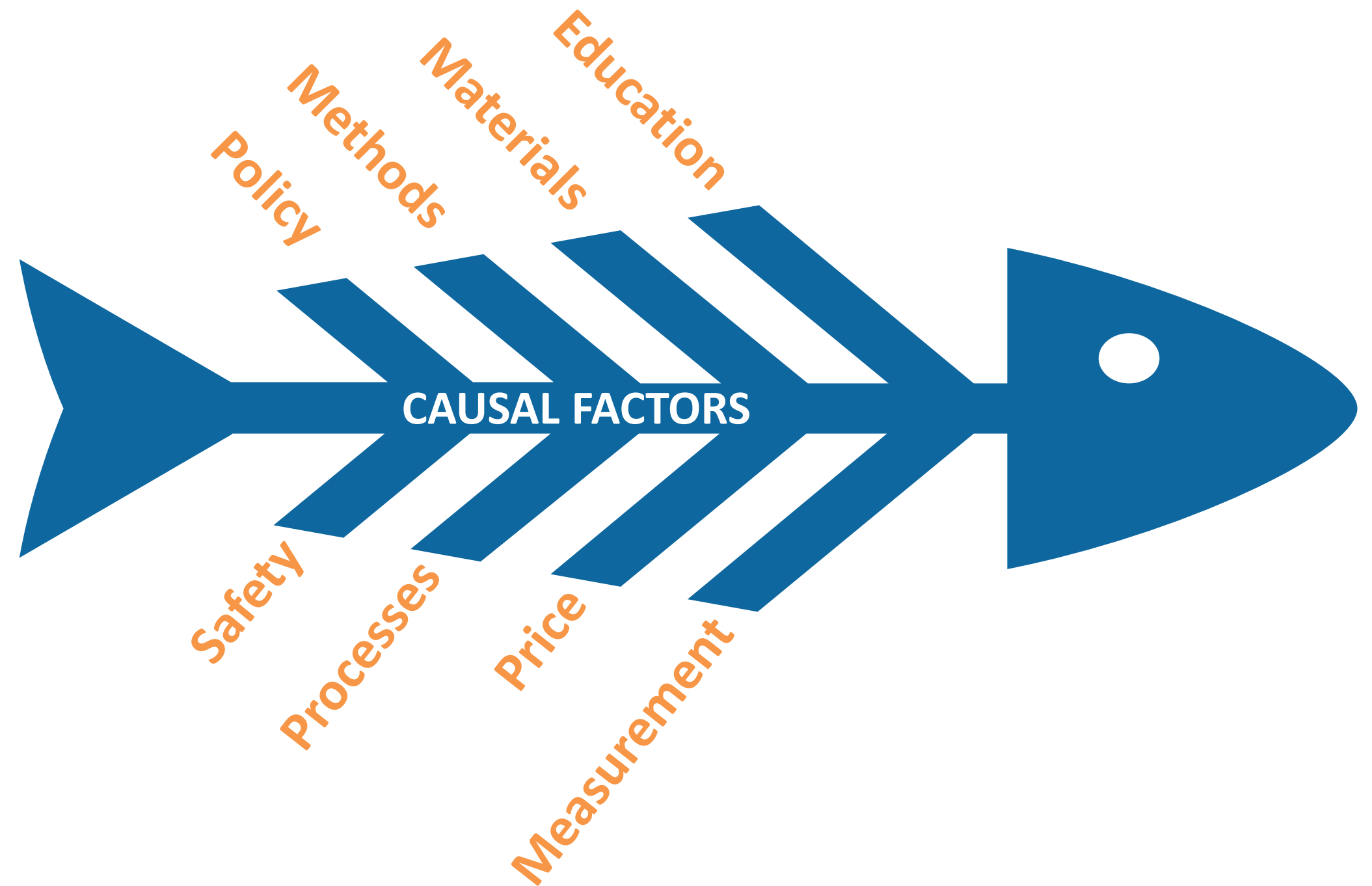
**LOW CARBON  
CONCRETE**

**CARBONATION  
(OF CONCRETE)**

**RECARBONATION  
(OF CONCRETE)**

## PROBLEM STATEMENT

The implementation and adoption of innovative materials, technologies, design, and practices to achieve low carbon concrete has lagged behind their availability.





**Terminology**



**Identifying current “real world” issues with using carbon accounting**



**Identify areas where greater clarity is needed in carbon accounting / LCA**



**Ongoing  
Presentations and  
Information Sharing**

## Consortia Details

- No proprietary information shared
- No fees
- CRADA signed by all members
- Reach out to [lowcarbonconcrete@nist.gov](mailto:lowcarbonconcrete@nist.gov)



**For Members:** Informal meeting at the ACI Convention Tuesday 11/5 from 3:30-5:30pm in Franklin 9

# In-Person / Hybrid Consortium Meetings



NIST – Boulder Campus - July 2023



Heidelberg Materials Tour - Union Bridge Plant - July 2024



Cement and Concrete Reference Laboratory  
Fredrick, MD – July 2024

**3<sup>rd</sup> Annual Meeting TBA –  
Planning for July 2025 –  
Location TBD**



# Thank you!

NIST



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