Low-Carbon Cement v1.0

Workgroup Meeting #5
April 19, 2023

Housekeeping

- Workgroup members have the opportunity to actively participate throughout the meeting
  - Ask that you keep yourselves muted unless / until would like to speak
- We will ask and take questions throughout the session
  - Please use the raise your hand function
- All other attendees/observers are in listen-only mode
- Observers are free to submit questions in the question box
- We will follow up via email to answer any questions not addressed during the meeting
- The slides and a recording of the presentation will be posted online

Workgroup Members

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Jimmy Knowles	SEFA Group

AGENDA

- Protocol considerations
  - **GHG assessment boundary**
  - **Quantification**
    - Use of Environmental Product Declarations
    - Project Emission Calculations
  - **MRV**
    - Purchase/Use Attestation Form
  - **Other Follow-up**
    - ASTM Standards
    - Performance Standard Test
    - Crediting period – legally required
    - Leakage
    - CO_2 removals
    - Location
- Next steps

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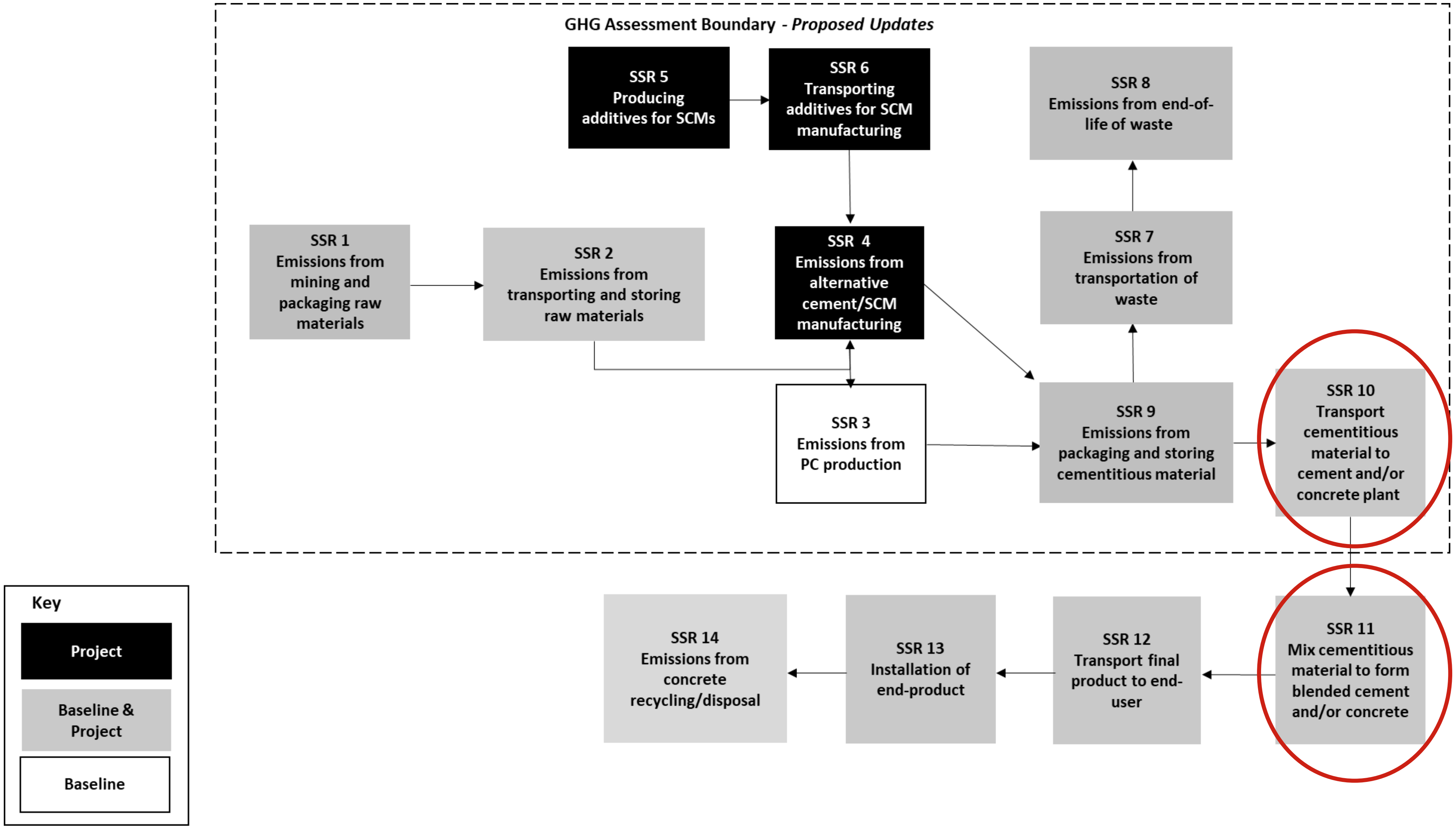
GHG ASSESSMENT BOUNDARY

The GHG Assessment Boundary



The GHG Assessment Boundary - Baseline

SSR	Description	Included Gas(es)	Quantification Method*
1	Emissions from mining raw materials	CO_2	Default factors – mining
2	Emissions from transportation and storage of raw materials	CO_2	Emission factors
3	Emissions from OPC production	CO_2, CH_4, N_2O, etc	Emissions based on electricity, fuel consumption & calcination
4	Emissions from packaging and storing cement	CO_2	Emissions based on electricity & fuel consumption
5	Emissions from transportation of waste	CO_2	Emission factors
6	Emissions from End-of-Life Waste	CO_2	Emission factors

The GHG Assessment Boundary - Project

SSR	Description	Included Gas(es)	Quantification Method*
1	Emissions from mining of raw materials	CO_2	Default factors – mining
2	Emissions from transportation and storage of raw materials	CO_2	Emission factors
3	Emissions from production of additives	CO_2, CH_4, N_2O, etc	Emissions based on electricity & fuel consumption
4	Emissions from transportation of additives	CO_2	Emission factors
5	Emissions from SCM manufacturing	CO_2, CH_4, N_2O, etc	Emissions based on electricity & fuel consumption
6	Emissions from packaging and storing cement	CO_2	Emissions based on electricity & fuel consumption
7	Emissions from transportation of waste	CO_2	Emission factors
8	Emissions from End-of-Life Waste	CO_2	Emission factors
9	Emissions from transport of cementitious material	CO_2	Emission factors

QUANTIFICATION

QUANTIFICATION – BASELINE EMISSIONS

Baseline

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- Portland Cement vs. Portland Limestone Cement as baseline
- Potential for dynamic or blended baseline
- Will SCMs replace PLC at the same rate as they will replace PC? If not, is PLC in the baseline appropriate?
- Potential to update baseline as PLC grows in market over next 5 years?

Quantification – Baseline Emission Factor

The determination of the emission factor for OPC production is carried out using one of the following three **hierarchical** approaches:

1. Historical OPC production records using plant-specific data
2. **Estimated emission factor using Environmental Product Declarations (EPDs)**
3. Published emission factor using regional data

Quantification – Baseline Emissions

Equation 5.2. Quantifying Total Baseline GHG Emissions

$$BE = (Q_b \times R_b \times EF_b)$$

Where,

			Units
BE	=	Total baseline emissions for the reporting period, from all SSRs in the GHG Assessment Boundary.	tCO_2e
Q_b	=	Total quantity of PC that would have been produced during the reporting period.	tonnes
R_b	=	PC to SCM/ACM weight adjustment factor in period during the reporting period.	percent
EF_b	=	CO_2 emission factor for PC production during the reporting period.	tCO_2e/tonne of PC

*Include end-of-life emissions in baseline as well?

Quantification – Baseline Emission Factor

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The determination of the emission factor for OPC production is carried out using one of the following three **hierarchical** approaches:

1. Historical OPC production records using plant-specific data

$$EF_b = \frac{(ME_b + PR_b + TE_b)}{Q}$$

Where,			Units
EF_b	=	CO_2 emission factor for PC production during the look-back period.	tCO_2e/tonne of PC
ME_b	=	Mining emissions for PC production during the look-back period.	tCO_2e
PR_b	=	Production emissions for PC production during the look-back period.	tCO_2e
TE_b	=	Transport emissions for PC production during the look-back period.	tCO_2e
Q	=	Quantity of PC produced during the look-back period.	tonnes

2. **Estimated emission factor using Environmental Product Declarations (EPDs)***
3. Published emission factor using regional data*

BASELINE EMISSIONS - PLANT SPECIFIC DATA APPROACH #1

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Quantification – Baseline Mining Emissions

- Plant Specific Data Approach

$$ME_b = (EL_{b,mining,grid} \times EF_{b,mining,grid}) + (FC_{b,mining} \times EF_{b,mining,fuel})$$

Where,			Units
ME_b	=	Mining emissions for PC production during the look-back period.	tCO_2e
$EL_{b,mining,grid}$	=	Grid electricity consumption for PC mining during the look-back period.	kWh
$EF_{b,mining,grid}$	=	CO_2 emission factor for grid electricity consumed during the look-back period from the most recent U.S. Environmental Protection Agency (EPA) eGRID emission factor publication.[20] Projects shall use the annual total output emission rates for the subregion where the project is located.	tCO_2/kWh
$FC_{b,mining}$	=	Fuel consumption for PC mining during the look-back period.	tonnes of fuel
$EF_{b,mining,fuel}$	=	CO_2 emission factor for fuel consumed during the look-back period from the most recent EPA Emission Factors for Greenhouse Gas Inventories.[21] Projects shall use the CO_2 factor for the appropriate fuel type.	tCO_2e/ tonne of fuel

Quantification – Baseline Production Emissions

- Plant Specific Data Approach

$$PR_b = EE_b + CE_b$$

Where,			Units
PR_b	=	Production emissions for PC production during the look-back period.	tCO_2e
EE_b	=	Energy emissions for PC production during the look-back period.	tCO_2e
CE_b	=	Calcination emissions for PC production during the look-back period.	tCO_2e

Quantification – Baseline Energy Emissions

- Plant Specific Data Approach

$$EE_b = (EL_{b,production,grid} \times EF_{b,production,grid}) + (FC_{b,production} \times EF_{b,production,fuel})$$

Where,			Units
EE_b	=	Energy emissions for PC production during the look-back period.	tCO_2e
$EL_{b,production, grid}$	=	Grid electricity consumption for PC production during the look-back period.	kWh
$EF_{b,production,grid}$	=	CO_2 emission factor for grid electricity consumed during the look-back period from the most recent EPA eGRID emission factor publication.[22] Projects shall use the annual total output emission rates for the subregion where the project is located.	tCO_2/kWh
$FC_{b,production}$	=	Fuel consumption for PC production during the look-back period.	tonnes of fuel
$EF_{b,production,fuel}$	=	CO_2 emission factor for fuel consumed during the look-back period from the most recent EPA Emission Factors for Greenhouse Gas Inventories.[23] Projects shall use the CO_2 factor for the appropriate fuel type.	tCO_2e/ tonne of fuel

Quantification – Baseline Calcination Emissions

- Plant Specific Data Approach

$$CE_b = R_{b,clinker} \times EF_{b,clinker}$$

Where			Units
CE_b	=	Calcination emissions for PC production during the look-back period.	tCO_2e
$R_{b,clinker}$	=	Clinker to cement ratio for PC production during the look-back period.	Percent
$EF_{b,clinker}$	=	CO_2 emission factor for clinker during the reporting period from the most recent national emissions data.[24]	tCO_2e/ tonne of clinker

Quantification – Baseline Trasnport Emissions

- Plant Specific Data Approach

$$TE_b = \sum d_b \times EF_{b,transport}$$

Where,			Units
TE_b	=	Transport emissions for PC production during the look-back period.	tCO_2e
d_b	=	Distance traveled for PC production during the look-back period.	miles
$EF_{b,transport}$	=	CO_2 emission factor for mode of transport during the look-back. Period from the most recent EPA Emission Factors for Greenhouse Gas Inventories.[25] Projects shall use the CO_2 factor for the appropriate transportation mode.	tCO_2e/ mile

QUANTIFICATION – PROJECT EMISSIONS

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Quantification – Project Emissions

Total emissions for production of SCM manufacturing

- Mining emissions for SCM production
- SCM production emissions
- Transportation emissions for SCM production
- Transportation emissions for SCM production
- Mining emissions for production and transportation of additives
- End-of-life of waste emissions

$$PE = \sum_{s} ME_{t,s} + PR_{t,s} + TE_{t,s} + WE_{t,s} + AD_{t,s}$$

Where,

			Units
PE	=	Project emissions for SCM manufacturing during the reporting period.	tCO_2e
$ME_{t,s}$	=	Mining emissions for SCM manufacturing during the reporting period for all eligible SCMs "s".	tCO_2e
$PR_{t,s}$	=	Production emissions for SCM manufacturing during the reporting period for all eligible SCMs "s".	tCO_2e
$TE_{t,s}$	=	Transport emissions for SCM inputs to manufacturing, storage, additives, and waste during the reporting period for all eligible SCMs "s".	tCO_2e
$WE_{t,s}$		End-of-life of waste emissions generated during SCM manufacturing	tCO_2e
$AD_{t,s}$	=	Additive production emissions for SCM manufacturing during the reporting period.	tCO_2e

Quantification – Mining Emissions

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- Mining emissions for SCM production
- SCM production emissions
- Transportation emissions for SCM production
- Transportation emissions for SCM production
- Mining emissions for production and transportation of additives
- End-of-life of waste emissions

$$ME_t = (EL_{t,mining,grid} \times EF_{t,mining,grid}) + (FC_{t,mining} \times EF_{t,mining,fuel})$$

Where,

			Units
ME_t	=	Mining emissions for inputs to SCM manufacturing during the reporting period.	tCO_2e
$EL_{t,mining,grid}$	=	Grid electricity consumption for SCM mining during the reporting period.	kWh
$EF_{t,mining,grid}$	=	CO_2 emission factor for grid electricity consumed during mining in the reporting period from the most recent EPA eGRID emission factor publication.[29] Projects shall use the annual total output emission rates for the subregion where the project is located.	tCO_2/kWh
$FC_{t,mining}$	=	Fuel consumption for SCM mining during the reporting period.	tonnes of fuel
$EF_{t,mining,fuel}$	=	CO_2 emission factor for fuel consumed during the reporting period from the most recent EPA Emission Factors for Greenhouse Gas Inventories.[30] Projects shall use the CO_2 factor for the appropriate fuel type.	tCO_2/ tonne of fuel

Quantification – Mining Emissions

- Mining emissions for SCM production
- SCM production emissions
- Transportation emissions for SCM production
- Mining emissions for production and transportation of additives
- End-of-life of waste emissions

$$PR_{t,s} = (EL_{t,production,grid} \times EF_{t,production,grid}) + (FC_{t,production} \times EF_{t,production,fuel})$$

Where,

			Units
$PR_{t,s}$	=	Production emissions for SCM manufacturing during the reporting period.	tCO_2e
$EL_{t,production, grid}$	=	Grid electricity consumption for SCM manufacturing or CO_2 capture/compression during the reporting period.	kWh
$EF_{t,production,grid}$	=	CO_2 emission factor for grid electricity consumed during the reporting period from the most recent EPA grid emission factor publication.[31] Projects shall use the annual total output emission rates for the subregion where the project is located.	tCO_2/kWh
$FC_{t,production}$	=	Fuel consumption for SCM production CO_2 capture/compression during the reporting period.	tonnes of fuel
$EF_{t,production,fuel}$	=	CO_2 emission factor for fuel consumed during the reporting period from the most recent EPA Emission Factors for Greenhouse Gas Inventories.[32] Projects shall use the CO_2 factor for the appropriate fuel type.	tCO_2/tonne of fuel

Quantification – Transportation Emissions

- Mining emissions for SCM production
- SCM production emissions
- Transportation emissions for SCM production
- Mining emissions for production and transportation of additives
- End-of-life of waste emissions

$$TE_{t,s} = \sum_{s} d_{t,s} \times EF_{t,s,transport}$$

Where,

			Units
$TE_{t,s}$	=	Transport emissions for SCM inputs to manufacturing, storage, additives, captured CO_2, and waste during the reporting period for all eligible SCMs “s”.	tCO_2e
$d_{t,s}$	=	Distance traveled for SCM manufacturing during the reporting period.	miles
$EF_{t,s,transport}$	=	CO_2 emission factor for mode of transport during the reporting period from the most recent EPA Emission Factors for Greenhouse Gas Inventories.[33] Projects shall use the CO_2 factor for the appropriate transportation mode.	tCO_2/ mile

Quantification – End-of-Life Waste Emissions

- Mining emissions for SCM production
- SCM production emissions
- Transportation emissions for SCM production
- Mining emissions for production and transportation of additives
- End-of-life of waste emissions

$$WE_{t,s} = \sum_{s} qw_{t,s} \times EF_{t,s,waste}$$

Where,			Units
$WE_{t,s}$	=	End-of-life waste emissions generated during SCM manufacturing	tCO_2e
$qw_{t,s}$	=	Quantity of waste generated during SCM manufacturing.	t
$EF_{t,s,transport}$	=	CO_2 emission factor for end-of-life of waste from the most recent X. Projects shall use the CO_2 factor for the appropriate disposal method (landfill, incineration, recycling.	tCO_2/t

Emission factors from ecoinvest or LCA commons?

Quantification – Additives

- Hierarchy for data
  - Estimated emission factor using EPDs

$$AD_{t,s} = \sum_{s} Q_{t,ad} \times EF_{t,ad}$$

Where,

			Units
$AD_{t,s}$	=	Emissions for additive production during the reporting period for all eligible SCMs.	tCO_2e
$Q_{t,ad}$	=	Quantity of additives used during the reporting period.	tonnes
$EF_{t,a}$	=	CO_2 emission factor for additive production during the reporting period.	tCO_2/tonne of additive

  - Published emission factor using regional data

MONITORING, REPORTING AND VERIFICATION

Proof of Purchase and Use

- Sales receipts
- Bills of Lading (BOL)
  - Weight of SCM sold
- Purchase & Use Attestation Form
  - Signature of supplier (SCM manufacturer) and purchaser (cement or concrete facility)
  - Attest the product is of specific quantity and quality
  - Attest the product will be used instead of PC to displace clinker in the market
- Time periods?

FOLLOW-UP

ASTM Standards

Eligible SCM/ACM	ASTM Standard Specifications	ASTM Standard Test Methods
Beneficiated ash	C618-23ε1: Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete	C311/C311M-22: Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
Natural pozzolans	C618-23ε1: Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete	C311/C311M-22: Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
Ground glass pozzolans	C1866/C1866M – 20: Standard Specification for Ground-Glass Pozzolan for Use in Concrete	C109/C109M, C311/C311M, C1069, C1293, C1567
Calcined clays/shale and/or metakaolin	C618-23ε1: Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete	
Limestone calcined clay cements (L2/3)	C595/C595M – 21: Standard Specification for Blended Hydraulic Cements (Type IT ASTM C1157/C1157M)	C109/109M, C114, C151,C151M, C183/C183M, C185, C187, C188, C191, C204, C311/C311M, C430, C1012/C1012M, C1038/C1038M
CO_2 / Biochar	Standard Specification for Cement that Hardens by Carbonation (under development)	Standard Test Methods for Cementitious Materials that Harden by Carbonation

ASTM Standards

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Eligible SCM/ACM	ASTM Standard Specifications	ASTM Standard Test Methods
Ternary blends (including eligible SCMs/ACMs)	C595/C595M – 21: Standard Specification for Blended Hydraulic Cements (Type IT ASTM C1157/C1157M)	
Other artificial pozzolans or treated calcined materials (including rice husk ash)	C150? C595? C1157? C456? C1709? Components within one of the standards for the products without specific ASTMs? Not appropriate?	
Other waste by-products (including Bauxite residue (Red Mud), lime kiln dust, or cement kiln dust)	C150? C595? C1157? C456? C1709? Components within one of the standards for the products without specific ASTMs? Not appropriate?	
Manufactured ACMs	C150? C595? C1157? C456? C1709? Components within one of the standards for the products without specific ASTMs? Not appropriate?	
Hydroxide products (including portlandite ($Ca(OH)_2$) and brucite ($Mg(OH)_2$))	C150? C595? C1157? C456? C1709? Components within one of the standards for the products without specific ASTMs? Not appropriate?	
Other novel SCMs (including biogenic limestone)	C150? C595? C1157? C456? C1709? Components within one of the standards for the products without specific ASTMs? Not appropriate?	

Crediting Period/Legal Requirement Test

- The crediting period for projects under this protocol is ten years. At the end of a project's first crediting period, project developers may apply for eligibility under a second crediting period. However, the Reserve will cease to issue CRTs for GHG reductions if, at any point in the future, the production of eligible SCMs/ACMs or the inclusion of eligible SCMs/ACMs in concrete becomes legally required, as defined by the terms of the legal requirement test (see Section 3.4.1).

- The Reserve did not identify any existing federal regulations that obligate the production of SCMs/ACMs. However, some states have legal requirements to beneficiate ash for use in concrete which would deem the project ineligible based on the legal requirement test. A summary of the Reserve's research on legal requirements is provided in Appendix A.

- If an eligible project begins operation at a SCM/ACM manufacturing site that later becomes subject to a regulation that calls for the production of eligible SCMs, emission reductions may be reported to the Reserve up until the date that eligible SCMs are legally required to be produced.

Additionality – Legal Requirement Test

- The U.S. currently has no federal regulation, such as a cap-and-trade program or carbon tax, that requires GHG emission reductions in the cement industry. Nor are there any national laws that require the production of SCMs/ACMs, blended cement, or SCM/ACM concrete.
- To satisfy the Legal Requirement Test, project developers must submit a signed Attestation of Voluntary Implementation form prior to the commencement of verification activities each time the project is verified (see Section 8).
- State level considerations:
  - California's GHG cap-and-trade program applies to cement plants
  - California Department of Transportation (Caltrans) already sets minimum amounts of required SCMs in state pavement and structure applications. These minimum requirements include 20% to 25% natural pozzolan or fly ash, 12% silica fume or metakaolin, or 50% GGBFS.
  - New Jersey's concrete mandate (S3091/A4933) that incentivizes lower carbon concrete for state projects by offering a tax credit for builders.
  - North Carolina Coal Ash Management Act created a legal requirement that the "installation and operation" of three "ash beneficiation projects, each capable of annually processing 300,000 tons of ash to specifications appropriate for cementitious products."

Additionality – Performance Standard Test

- Based on this market penetration to date, these products were found to be ineligible under this protocol.
  - Using regional benchmarks conducted by NRMCA, the national average of cement used in the United States is approximately 81%, Portland cement, 14% fly ash cement and 4% slag cement (NRMCA Regional Benchmarking).
  - Since silica fume is a niche product, it does not have a significant presence in the United States market. However, it is found to be readily available across the United States and common practice in specific situations.*
  - ACMs?
- The Project Developer must demonstrate that the usage rate of the novel SCMs/ACMs in concrete is either near zero (first-of-its kind) and thus has insufficient data to calculate a penetration rate or provide evidence that production of the SCM/ACM product is less than 5% of PC production in the United States.

Other items

- Leakage (Section 5.1.2)
  - Purchase/Use Attestation Form or list of questions (TBD)

- CO_2 Removals – excluded, TBD V1.1 or CCS

- Location – specific to USA, TBD V1.1

NEXT STEPS

Next Steps

- Email us with any feedback on topics discussed today
- **Final comments/feedback on V4 of draft protocol by April 26, 2023 (two weeks)**
- Reach out any time to discuss protocol topics or process
- Protocol revisions by Reserve staff – *ongoing*
- ***Public Comment Period –May 2023***

Key contacts

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THANK YOU!

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