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Low-Carbon Cement v1.0

Workgroup Meeting #2
January 20, 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

AGENDA

- Protocol considerations
  - Eligibility
    - **Project definition**
    - **Ownership / Aggregation**
    - **Start Date / Crediting period**
    - **Project Location**
    - **Additionality**
    - **Regulatory Compliance**
  - GHG assessment boundary
  - Quantification
  - Monitoring / Reporting / Verification
- Open Discussion
- Next steps

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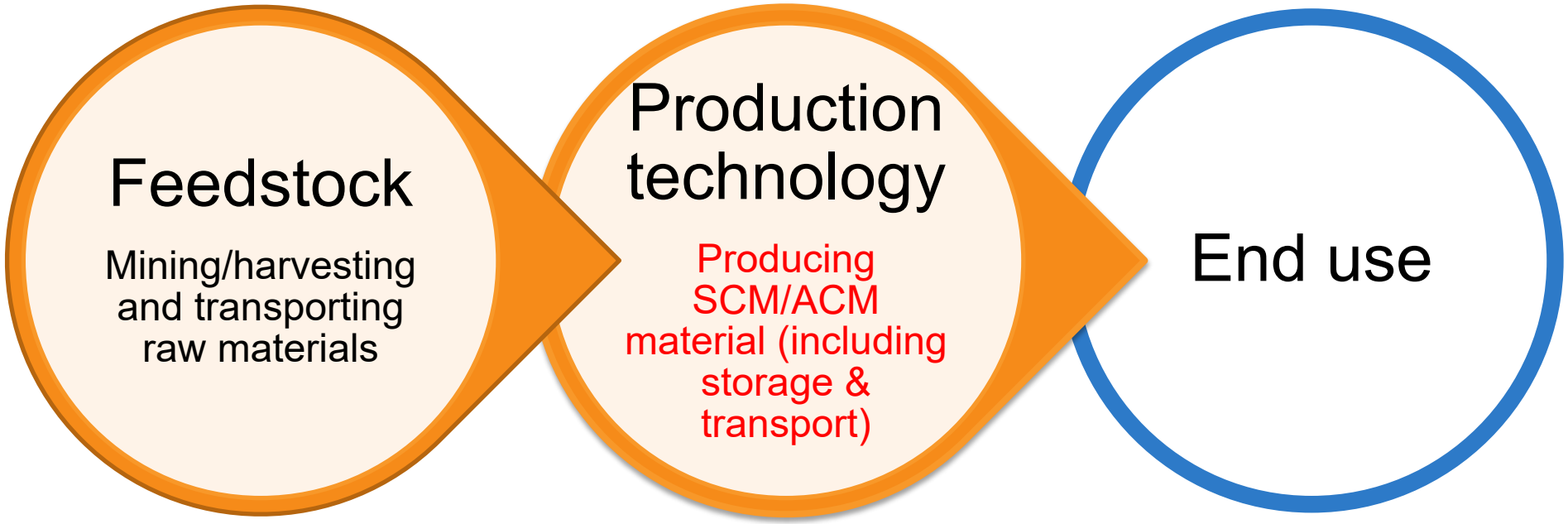
ELIGIBILITY

Project Definition



The **production** of upgraded or novel SCMs or ACMs that can be used to partially or fully replace Portland Cement

For the purpose of this protocol, the GHG reduction project is defined as the manufacturing of SCMs or ACMs that can partially or fully replace Portland Cement. The project results in the avoidance of GHG emissions from Portland Cement manufacturing.

Project Definition

End Uses

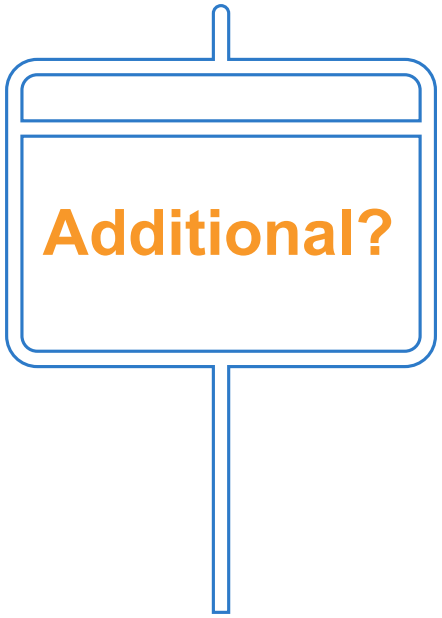
Eligible end uses for which SCM/ACM can reasonably displace clinker in Portland Cement, e.g., ready mix concrete, cement production, etc.

Intent is to allow flexibility for a range of end uses:

- Other eligibility requirements (regulatory and environmental safeguards) may screen out some potential end uses
- Blended cement vs. ready mix
- Should we define end uses that are specifically ineligible (e.g.,)?
- Some states require the use of SCMs in state projects. Is this ineligible?

Project Eligibility

- **Need to define goal posts for product eligibility to determine exclusion**
- **Focus on exclusion or negative list – rather than eligibility to remain agnostic**



Is it common practice? Yes? (define/%)

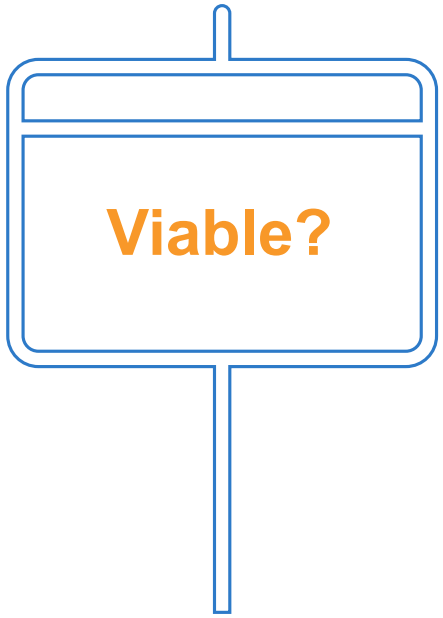
Does it meet quality standards (ASTM, others?)? No?

Is it legally required? Yes?

Is it available in the U.S.? No? (define/%)

Are there barriers to adopt? Yes? (define)

Is it scalable/will it displace Portland Cement? No? (define)



Types of Coal Ash

Fresh Ash	Beneficiated Ash	
N/A	Upgraded	Harvested
	Bottom or fly ash that requires processing to meet concrete specifications	
Used directly from an operational power plant without further processing	Bottom or fly ash from operational coal-fired power plant	Bottom or fly ash from operational or decommissioned power plant that is harvested from landfill/impoundment

X amount of **time** for 'harvested'
X amount of **process** for 'upgraded'

** add language to protocol to clearly define beneficiated to exclude co-firing

Quality Standards

Standards for materials:

- ASTM International, formerly known as the American Society for Testing and Materials, establishes procedures and standards for testing cements; to be ASTM-certified ~~as OPC~~, the product must include 90% to 95% OPC clinker.
  - Relevant cement and concrete standards

Additional limits or certifications?

Project Eligibility

Ineligible (common/storage)	**Eligible** (SCM/ACM/Kiln)	**Potential** (i.e., etc.)	**Ineligible** (scale/impact)
Fresh Fly Ash	Beneficiated Ash	Rice Husk Ash	Silica Fume
Ground Granulated Blast Furnace Slag (GGBFS)	Natural pozzolans	Waste-to-Energy Ash/ Incinerator Ash	Limestone calcined clay cement (L3)
	Novel artificial pozzolans or treated calcined materials	CO2	Calcinated Clays or Metakaolin
	Manufactured substitutes for fly ash	Biogenic Limestone	Ternary Blend of Ineligible Products
		Biochar	
		Geopolymer cements or alkali-activated materials	
		Bauxite Residue (Red Mud)	
		Burnt Shale	

Project Ownership

Who is issued offset credits?

- SCM/ACM producer
- Cement manufacturer
- Ready mix concrete facility
- End user

Likely will assign the SCM/ACM producer as the project owner by default:

- Control over feedstock sourcing, SCM production, and transactions with end users
- Contractual agreements can include chain of ownership with GHG reduction claims to ensure clarity and avoid double counting. Purchase orders could be used to ensure that SCMs are used as an OPC replacement.

Project Ownership - Aggregation

Combining multiple actors, activities, and locations into a single “project” for purposes of monitoring, reporting, verification, and credit issuance.

Should projects be allowed to aggregate and under what conditions?

- Same or similar SCM/ACM
- Multiple SCMs/ACMs at one site
- Geography
- Scale of production

Location, Start Date and Crediting/Reporting Period

➢ Location

Under this protocol, projects located in the United States, U.S. tribal lands and territories are eligible to register with the Reserve.

- Consider including Canada / Mexico. North American Trade? Canadian/ Mexico Regulations?
- Can feedstocks or end uses be located outside of the US?

➢ Start date

First date that production of SCM for which credit issuance is sought

➢ Crediting period

10 years, renewable for another 10 year crediting period

➢ Reporting period

Flexible, based on SCM production, with maximum of 12 months

Regulatory Compliance

- Focus is on laws/regulations related to SCM/ACM and Cement production
- Project activities must be in compliance with relevant laws and regulations
  - Air, water, safety, etc.
- Project developers must submit a singed Attestation of Regulatory Compliance form
- Feedstocks and end uses addressed largely through eligibility requirements

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GHG ASSESSMENT BOUNDARY

The GHG Assessment Boundary

Purpose

Account for significant GHG impacts from the project activity relative to the baseline.

- Delineates the GHG sources, sinks, and reservoirs (SSRs) that shall be assessed by project developers in order to determine the total net change in GHG emissions caused by a low carbon cement project.

Scope includes feedstocks, production process, and end use

Inclusion of any individual SSR depends on project configuration and applicable baseline scenario.

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

*proposed

3, or majority of baseline, likely not included in jurisdictions under cap-and-trade

- Are any SSRs missing from this table that should be included?
- Are any SSRs included in this table that should *not* be included?

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	Others from end use?	CO_2, CH_4, N_2O, etc	Default factors

*proposed

- Are there any SSRs that are missing or that should *not* be included?

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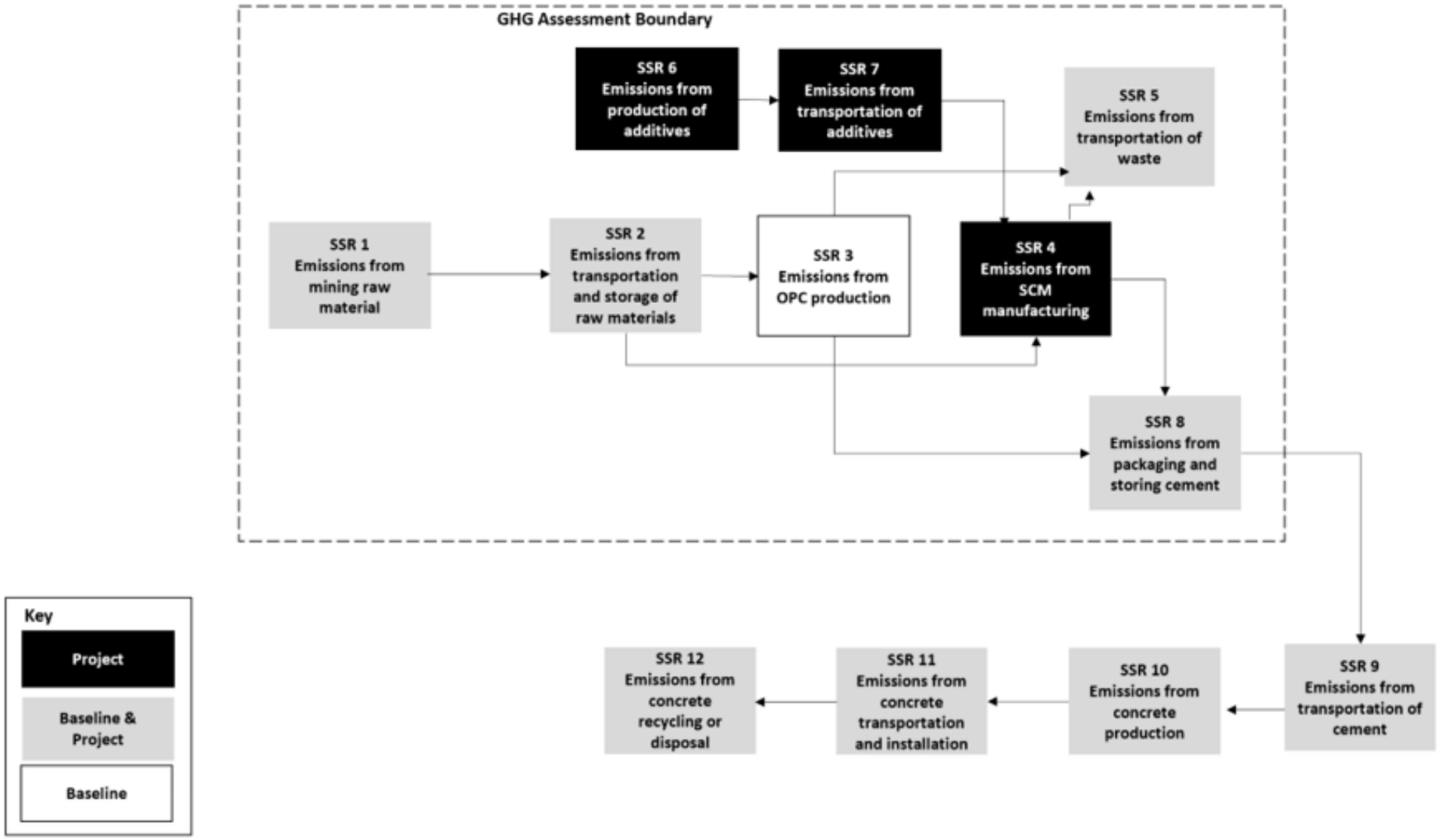
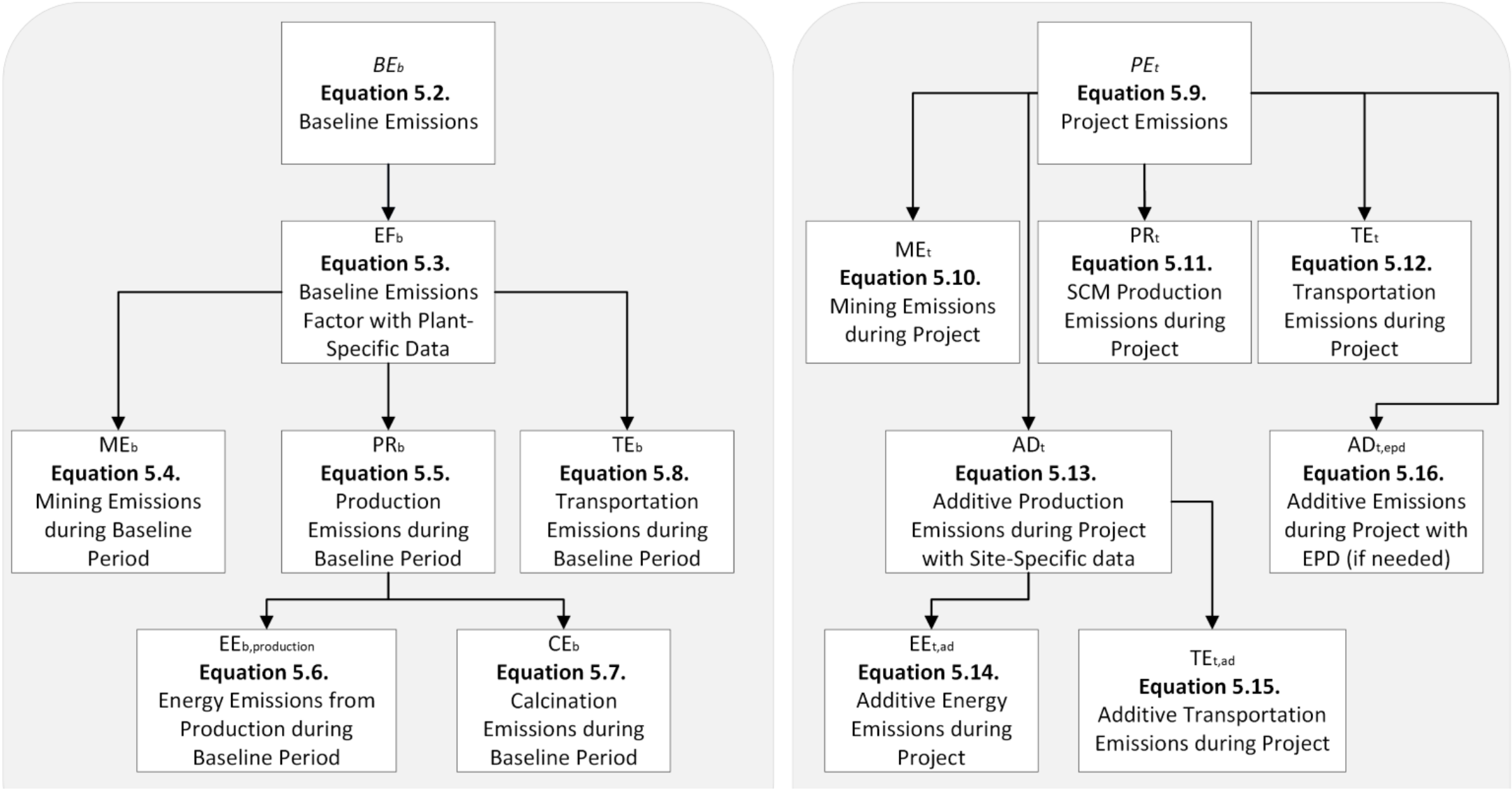
QUANTIFICATION

Quantification



Quantification



Quantification

Baseline Emissions

Total emissions for production of OPC

- Mining emissions for OPC production
- OPC production emissions including calcination
- Transportation emissions for OPC production

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

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 OPC that would have been produced during the reporting period.	tonnes
R_b	=	OPC to SCM weight adjustment factor in period during the reporting period.	percent
EF_b	=	CO_2 emission factor for OPC production during the reporting period.	tCO_2e/tonne of OPC

Quantification

Baseline Emissions

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
   - Challenges if the project developer is not the OPC manufacturer
2. **Estimated emission factor using Environmental Product Declarations (EPDs)**
   - **Publicly available data for each location?**
3. Published emission factor using regional data

Availability of this data and/or ability for industry to publicly or confidentially share data?

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

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

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
$AD_{t,s}$	=	Additive production emissions for SCM manufacturing during the reporting period.	tCO_2e

Quantification

Project Emissions

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

Quantification

Additives

For simplicity and usability, the project developer may exclude emissions for additives that make up 5% or less of the total SCM product by weight as these emissions are considered negligible.

- If total additives make up **5% or more** of the final SCM product by weight, the emissions associated with the primary additive(s) must be calculated. Secondary additives may be excluded from the calculation up to 5% of the total SCM product by weight.
- For example, if a product is made up of 4.5% gypsum, 2% lime, and 1.5% other activators for a total of 8% additives.
  - The project proponent would be required to quantify emissions from the production of the primary additive (gypsum).
  - Since the secondary additives (lime and other activators) make up less than 5% of the weight of the final SCM product, their emissions may be excluded from the calculation as they would be considered negligible.

Is 5% the correct limit? Why or why not?

Leakage

Leakage may occur if the project increases GHG emissions outside of the project's assessment boundary as a result of the project activity

1. Amount of OPC or clinker in the market is not reduced with accessibility to alternative SCM products (due to cost, quality of product, location, etc)
2. How can we determine displacement of OPC – should there be a mechanism to determine this to avoid leakage? Sales receipt?
3. SCMs will increase rather than being diverted from one facility to another – therefore leakage risk is centralized on displacement of OPC in the market.
4. Mining and transportation leakage concerns are imbedded in baseline and project emission calculations
5. Inability to use many SCMs beyond a certain replacement rate before negatively impacting the performance of concrete (ASTM Standards)
6. Are there any other leakage risks associated with this protocol?

Equation 5.2 includes total quantity of OPC that would have been produced during the reporting period – does this protect against leakage concerns from displaced OPC?

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MONITORING, REPORTING AND VERIFICATION

Monitoring / Reporting / Verification (MRV)

Monitoring	Data Collection	Reporting Period	Verification
• Data collection frequency • Record keeping plan • QA/QC provisions • Legal requirement test	• Electricity and fuel consumption • Distance traveled • Quantity of SCM produced • Weight adjustment factor • OPC emission factor	• Flexible, based on SCM production, with maximum of 12 months	• Documentation and data review • Data management • Site visit

Monitoring / Reporting / Verification (MRV)

- Chain-of-custody tracking to document transfers from feedstock source to SCM producer to end use
- Standardized quantification/reporting tool to streamline reporting and verification
- Require physical verification site visits during initial verification and at least once every two reporting periods thereafter
- Can we leverage existing certification programs (e.g., ASTM standards, other standards?) to streamline our MRV process, including demonstration that some eligibility requirements have been met? Devil will be in the details.

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OPEN DISCUSSION – FEEDBACK AND SUGGESTIONS

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NEXT STEPS

Next Steps

- Email us with any feedback on topics discussed today
- **Submit comments/feedback by January 20, 2023**
- Reach out any time to discuss protocol topics or process
- Protocol revisions by Reserve staff – *ongoing*
- ***Share protocol draft with workgroup***
- ***Workgroup Meeting 3 – January/February 2023***
  - Review draft protocol, section by section
  - ~2-4 hour session via Zoom

Key contacts

Protocol development lead:

McKenzie Smith, Analytical Team Manager

msmith@climateactionreserve.org

General inquiries:

Policy@climateactionreserve.org

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THANK YOU!

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ADDITIONAL BACKGROUND SLIDES

Project Definition

The following are being proposed as ineligible project activities.
Is this list complete? Are there any other products that should be listed as ineligible? Any that should be eligible that are listed here as ineligible?

Product	Description	Reasoning
Fresh fly ash	A by-product of coal-fired power generation that is beneficially used directly from the power plant without further processing.	Fresh fly ash is commonly used as an SCM in the US. Fresh fly ash may not be additional and may result in leakage.
Ground granulated blast furnace slag (GGBFS)	A by-product of crude iron (also known as pig iron) production.	GGBFS is commonly used as an SCM in the US. GGBFS may not be additional and may result in leakage.
Silica fume	An extremely fine pozzolanic material that is derived from furnace smoke in the silicon metal production process.	Silica fume is costly, hard to handle, and used primarily for specialty applications. Carbon finance may not impact scalability.
Calcined clays or metakaolin	A highly reactive pozzolanic material made from the calcination of kaolin clays. To produce metakaolin, kaolin clays are run through a kiln and exposed to heat (1,300 to 1,600 degrees Fahrenheit) and then ground to form a fine powder.	Calcined clays are limited in use and require high energy consumption for kiln heating, therefore these SCMs may have a limited net environmental benefit.
Limestone calcined clay cement (LC^3)	LC^3 is a mix of calcined clay and limestone that can reduce OPC emissions by ~30 - 40%.	Limestone calcined clay cement requires about 50% Portland clinker and releases process emissions; therefore, this product may have a limited net environmental benefit.
Ternary blend of ineligible products	Ternary blends are a mix of multiple SCMs.	See product reasoning above.

Other Potentially Eligible Products

Product	Description	SCM Use
Rice husk ash	Rice husk ash is an agricultural byproduct from the rice paddy milling industry.	Rice husk ash can be used as a cement replacement up to 10 – 15%. It can improve concrete workability, strength, and permeability when used with proper ratios. It may increase setting time of concrete.
Waste-to-Energy Ash/ Incinerator Ash	Some cement producers use hard-to-recycle non-hazardous waste to fuel cement kilns; kiln combustion results in ash. Ash can also be produced from waste at municipal solid waste incineration facilities – in the US most of this ash is disposed in landfills.	Research shows that the ash may be processed for use as a cement replacement in concrete. However, stringent US regulations regarding waste-to-energy processes impact supply.
CO_2	Some companies are exploring potential to capture CO_2 from cement kilns and reusing it to form a reactive limestone or other usable product.	There are startup companies that capture CO_2 from cement kilns for use as an SCM. Additional research is required to understand the impact on concrete.
Biogenic Limestone	Microalgae, sunlight, and seawater can be used to capture and store CO_2 as biogenic limestone	There is a pre-seed startup company that is experimenting with biogenic limestone for use as an SCM.
Biochar	Biochar is made through thermochemical combustion of biomasses with total or partial absence of oxygen.	Recent studies show that biochar from various biomasses (food waste, wood waste, rice waste, etc.) can increase strength in concrete when used as cement-replacement in small amounts. Biochar is recognized for carbon sequestration by the IPCC (quantification may differ).

Other Potentially Eligible Products

Product	Description	SCM Use
Geopolymer cements or alkali-activated materials	Geopolymer cements are SCMs mixed with alkali silicate solutions.	Geopolymer cements include SCMs, but not all SCMs are considered geopolymer cement.
Bauxite Residue (Red Mud)	Bauxite residue is a solid byproduct of aluminum production that can inhibit corrosion in reinforced concrete and seems promising for usage in tandem with other SCM.	Red mud can be used to replace cement in concrete/mortar. Around 20% of cement can be replaced with red mud.
Glass Powder	Glass powder from municipal waste streams can be reused and sequestered. About 34% of glass is recycled in the US.	Glass powder can be used as both an aggregate and a SCM. Studies outline a replacement rate of OPC of around 20%. Glass powder may increase workability of concrete.
Burnt Shale	Byproduct of crude oil burning in power plants. Resulting ash from burning depends on a wide range of factors, from percentage organic matter and production temperature.	Burnt shale oil can replace ~35% of OPC and is also used in unique well casing situations because of resistance to corrosion and geological impacts.

SCM Drivers & Barriers

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Type of SCM	Drivers for Use	Barriers to Expansion
Fly Ash	• Performance improvements up to replacement ceiling (impermeability, durability, workability, etc.) • Cost is similar or less than OPC • Reduced GHG emissions	• Shortage due to declining regional supply • Variation in quality/composition • Industry standards favor OPC/limit replacement • Performance degradation beyond replacement ceiling (longer set time, early-age strength, etc.) • Infrastructure/storage costs • Lack of technology needed to harvest, and process disposed of fly ash • Lack of technology to mix beyond replacement ceiling
Slag Cement / GGBFS	• Performance improvements up to replacement ceiling (impermeability, workability, lighter color, etc.) • Cost is similar or less than OPC • Reduced GHG emissions	• Shortage due to low national volumes and declining regional supply • Transportation costs • Industry standards favor OPC/limit replacement • Perfomance degradation beyond replacement ceiling (longer set times, durability, etc.) • Infrastructure/storage costs • Lack of technology to mix beyond replacement ceiling
Silica Fume & Metakaolin	• Performance improvements up to replacement ceiling (density, strength, impermeability, etc.) • Reduced GHG emissions	• Cost of SCM is high • Limited regional availability • Low volumes available • Industry standards favor OPC/limit replacement • Performance degradation beyond replacement ceiling (workability, water demand, etc.) • Infrastructure/storage costs • Lack of technology to mix beyond replacement ceiling • High energy requirements for metakaolin kiln
Natural Pozzolans & Alternative SCMs	• Performance improvements up to replacement ceiling (strength) • Reduced GHG emissions	• Varying regional availability • Varying chemical composition • Extensive processing often required to utilize • Industry standards favor OPC/limit replacement • Performance degradation beyond replacement ceiling (early strength) • Infrastructure/storage costs • Widely accepted industry standards favor OPC • Lack of technology to beneficiate

Additionality

Ensuring only crediting for actions that go beyond what would occur in the absence of the project

Additionality

Performance standard - technology-specific threshold, practice-based threshold

- Production of upgraded/novel SCMs that can fully or partially replace OPC
- Offset credits provide a financial incentive to produce SCMs
  - Assess current industry practice for upgraded/novel SCM use in the United States
  - Assess barriers to adopting SCMs in the United States
- All other eligibility requirements met

Baseline scenario determination discussed later

Additionality

Legal Requirement Test - Project activities must not be legally required

- Did not identify any existing federal, state, or local regulations that obligate the production of upgraded or novel SCMs, however some states require the use of SCMs in state projects
- If any state agencies specifically require the replacement of OPC with upgraded or novel SCMs, projects that fall under the legislation in these regions may be ineligible for crediting
- Regulations for coal ash disposal?
- Cap-and-Trade?

Other Potentially Eligible Products

The workgroup may assess other OPC replacements. To determine eligibility, the workgroup should discuss:

- Is usage data available?
- How common is the product in the US?
- Are there other environmental and social impacts from producing or using the product?
- What is the potential scale of emission reductions?
- What impact does the replacement have on the final concrete product?
- Would quantification for the product and quality of the product align with the protocol?