Industrial Decarbonization in Washington

BIL Industry Funding Workshop

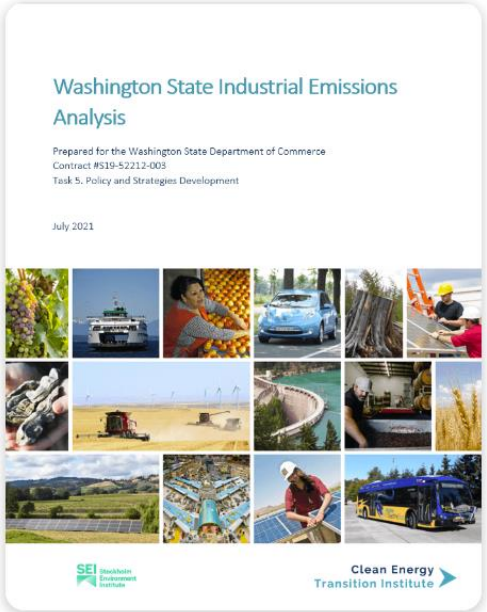
Ruby Moore-Bloom | August 17, 2022

CETI Industrial Emissions Analysis

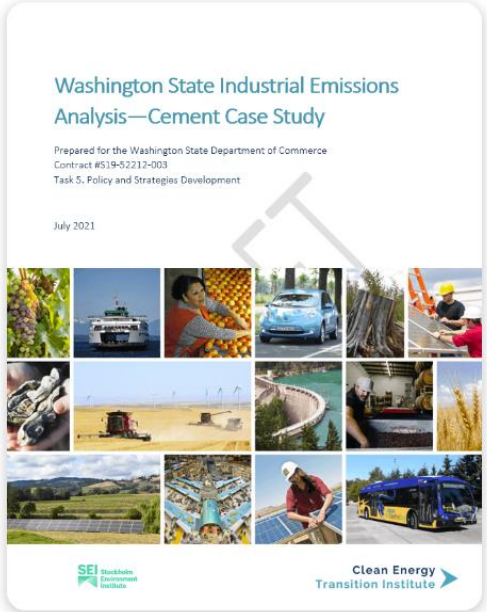
- https://www.cleanenergytransition.org/projects/washington-state-industrial-emissions-analysis

Washington State Industrial Emissions Analysis Documents:

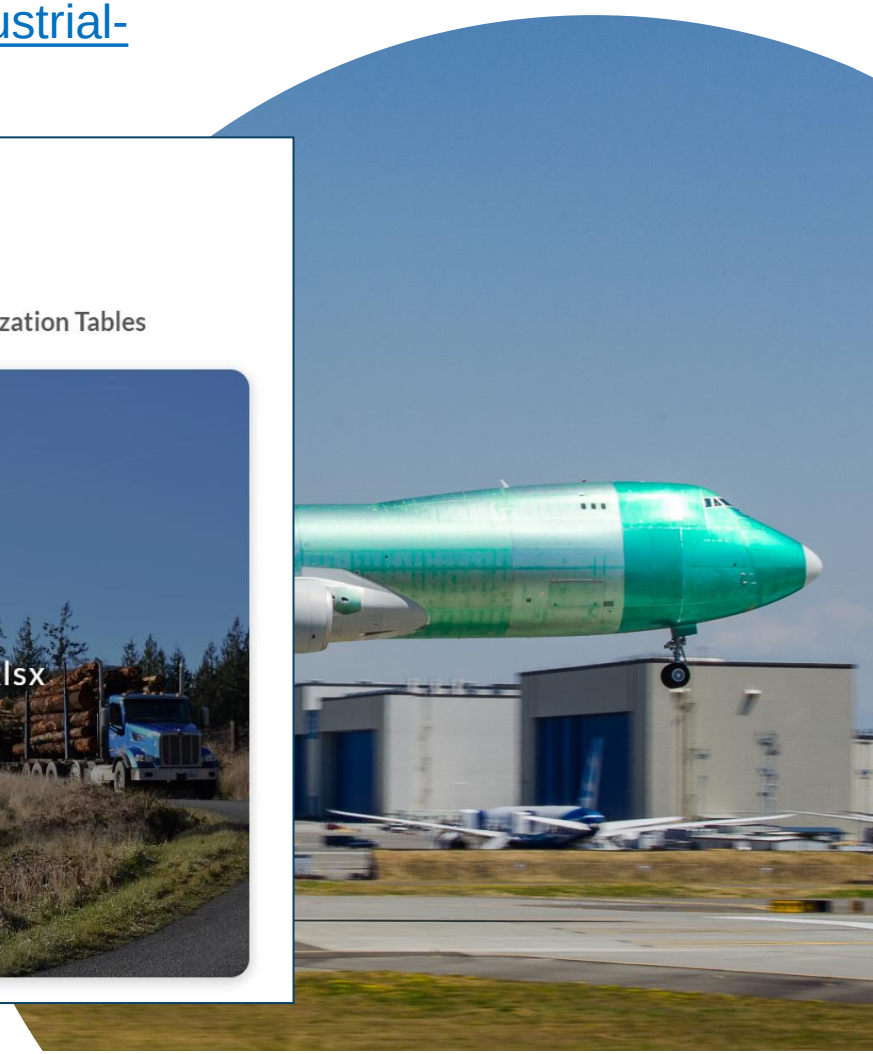
Final Report



Cement Case Study

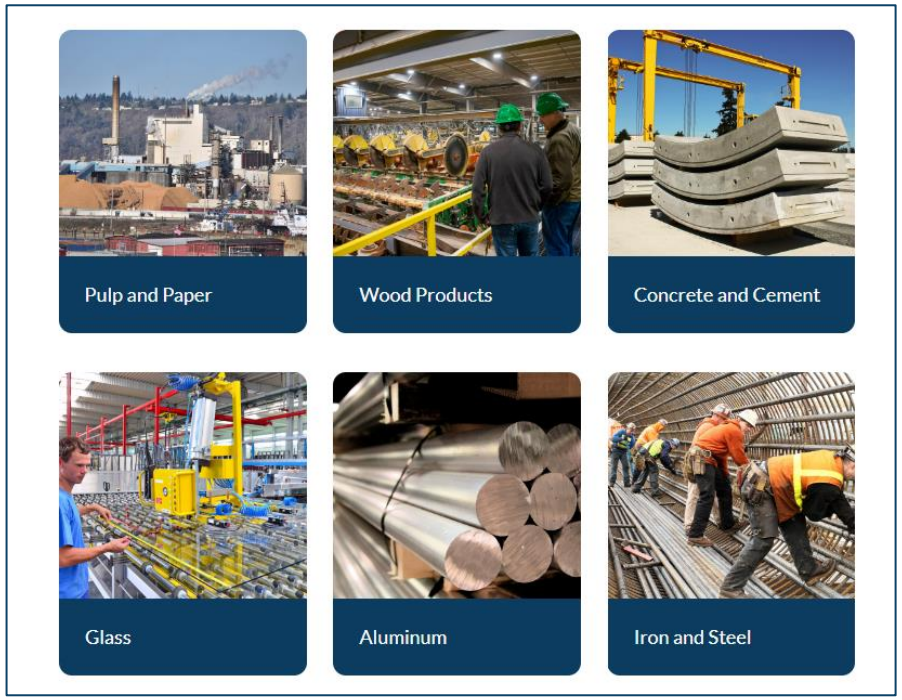


Characterization Tables



Clean Materials Manufacturing

- https://www.cleanenergytransition.org/cmm

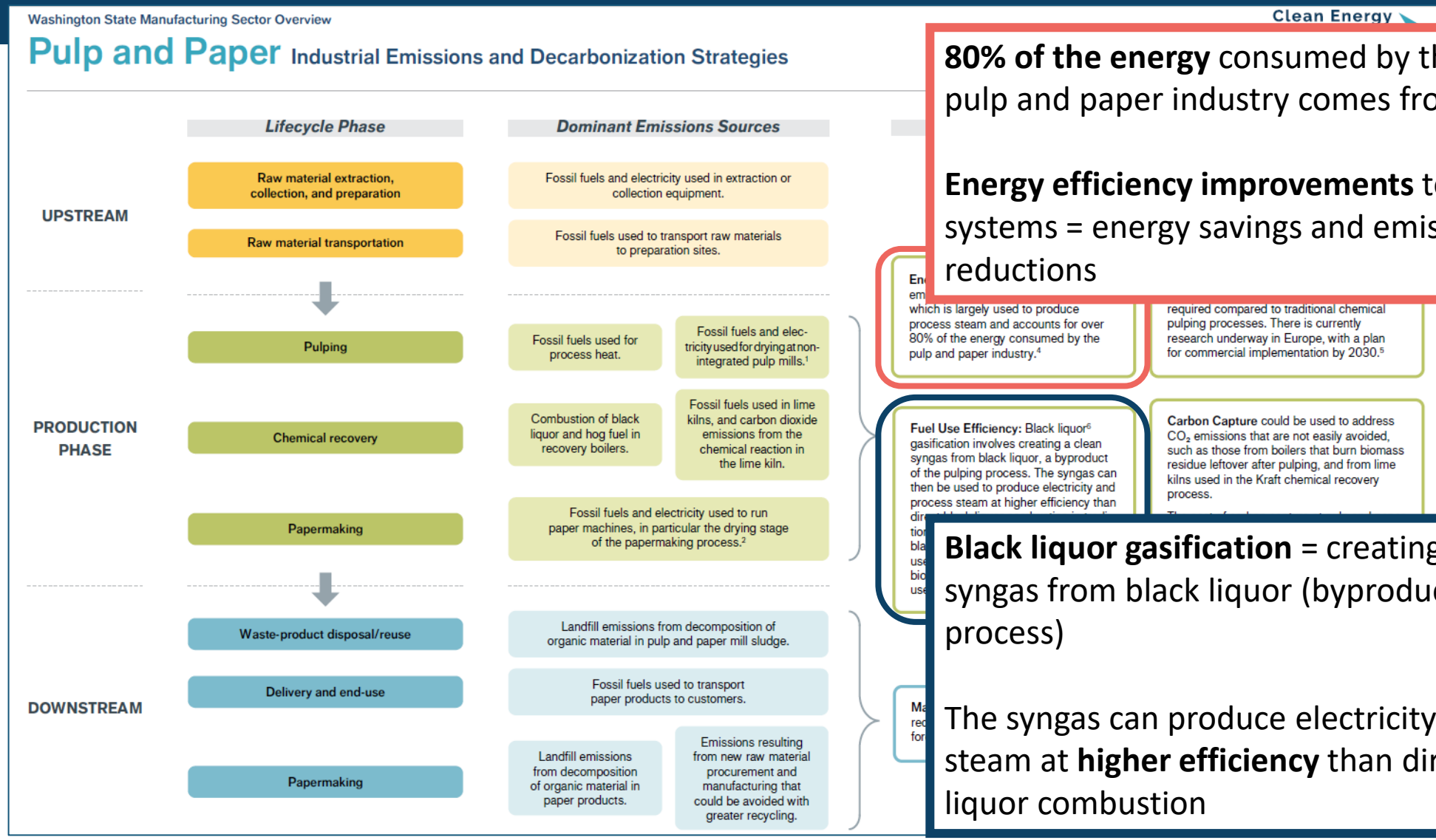


Industrial Decarbonization

Three cross-cutting strategies:

- Efficiency
- Waste Heat Recovery
- Process Emissions Reductions

1. Energy Use Efficiency & Fuel Use Efficiency



80% of the energy consumed by the pulp and paper industry comes from boiler fuel

Energy efficiency improvements to steam systems = energy savings and emissions reductions

Black liquor gasification = creating a clean syngas from black liquor (byproduct of pulping process)

The syngas can produce electricity and process steam at **higher efficiency** than direct black liquor combustion

2. Waste Heat Recovery

- **20-50%** of industrial energy input is lost as **waste heat**
- Waste heat can be recovered and reused
- Example in **glass manufacturing:**

2. Waste Heat Recovery

Washington State Manufacturing Sector Overview

Glass Industrial Emissions and Decarbonization Strategies

Clean Energy Transition Institute

Washington State Clean Materials Manufacturing

	Lifecycle Phase	Dominant Emissions Sources	Decarbonization Strategies
UPSTREAM	Raw material extraction (quarrying)	Fossil fuels and electricity used in extraction equipm including conveyors.	
	Raw material transportation	Fossil fuels used to transport raw materials to preparation sites.	
PRODUCTION PHASE	Batch preparation and mixing	Natural gas combustion and/or electricity producti for equipment operation.	
	Melting and refining	Fossil fuels combustion (natural gas) used to fire the furnace. / Production of electricity used for boosting furnace, if applicable. / Process emissio from th decarbon tion of sc ash and li	
	Conditioning and forming	Natural gas combustion and/or electricity production for heating of the forehearth and for equipment operation.	
	Finishing	Natural gas combustion and/or electricity production for equipment operation.	
DOWNSTREAM	Construction and end-use	Fossil fuels used in transport and use/installation of glass products.	
	Disposal	Fossil fuels used in collection, recycling, and reuse of glass products.	

Waste Heat Recovery: After waste heat is minimized as much as possible through equipment energy efficiency improvements and electrification, remaining waste heat can be recovered and reused to reduce overall energy demand and energy-related emissions. Waste heat can be reused for preheating of combustion gases, raw materials, and cullet; onsite building heating/cooling; electricity generation; or offsite heating needs through district heating systems.[4]

Material Efficiency: Increasing recycling of glass, which is limited to container glass and glass fibers, can significantly reduce CO_2 emissions from glass-making. However, the current rate of glass recycling is already high in the United States. Mixing recycled glass (cullet) with raw materials, or using cullet entirely, avoids both energy-related and process CO_2 emissions. Cullet has a lower melting temperature than the raw materials used in glass-making, requiring less process heat. Carbonate raw materials (limestone, dolomite, soda ash) also directly release CO_2 when heated for glass-making.[5]

Waste Heat Recovery

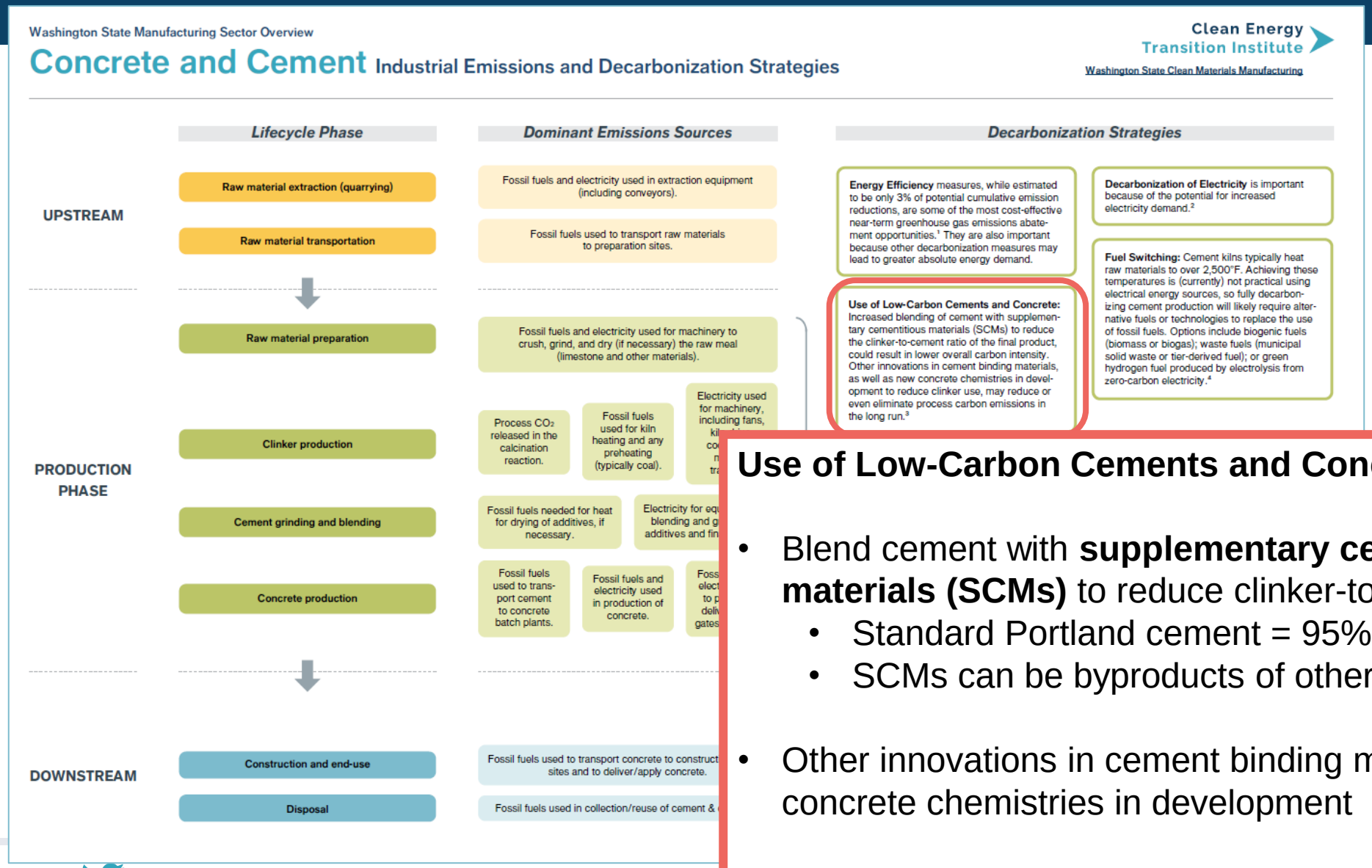
Potential uses:

- Preheating of combustion gases, raw materials, and cullet;
- Onsite building heating/cooling;
- Electricity generation;
- Offsite heating needs through district heating system

3. Process Emissions Reductions

- Direct process emissions = emissions that happen during the chemical production of a material
- Example = The production of **cement** releases CO_2 from the calcination of limestone used as a raw material
  - Calcination is responsible for ~two-thirds of the total direct CO_2 emissions from cement production

3. Process Emissions Reductions



Use of Low-Carbon Cements and Concrete

- Blend cement with **supplementary cementitious materials (SCMs)** to reduce clinker-to-cement ratio
  - Standard Portland cement = 95% clinker
  - SCMs can be byproducts of other industries
- Other innovations in cement binding materials, new concrete chemistries in development

Thank you very much

Ruby Moore-Bloom ruby@cleanenergytransition.org