



Data Issues in Sectoral Approaches

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Gauging an Industry's Suitability for Sectoral Approaches

- Some characteristics suitable for sectoral approaches
 - » Energy use and emissions large enough to warrant the effort
 - » Relatively uniform product
 - » Limited number and/or range of co-products
 - » Production processes that can be compared
 - » Abilities to measure, report & verify data
- Our study is exploring some of these issues specific to each industry
 - » “Proof of Concept” is the goal
 - » Where it could work, and where it might not
 - » Not all industries are well-suited for sectoral approaches

Going from theory to “Proof of Concept”

- Reality is often messier than theory
 - » Benchmarking, measurement, & boundary issues in each sector
 - » Differences among industries
 - » Variations within each industry
 - » Variations across countries
- No “one size fits all” for sectoral approaches
- These issues are especially important when incentives are introduced
 - » Before, measurements had fewer consequences
 - » After, measurements have financial implications
 - » *What* you measure, and *how* you measure, affects how rewards/penalties are distributed

Measurement Issues: Multiple Processes

- Often, a product can be produced using more than one technology
 - » Electricity: coal vs. natural gas vs. nuclear
 - » Coal-fueled electricity: supercritical, USC, IGCC
 - » Cement clinker: wet vs. dry process
 - » Steel: BOF vs. electric arc furnace
- Plant operators sometimes have choices. Sometimes not. Sectoral approaches should aim to:
 - » Reward the choice of "right" options when choices are possible
 - » Not penalize "poorer" options when there aren't really better ones
- Issue: Where to measure for sectoral programs?
 - » Measuring at end product doesn't relate well to specific processes
 - » Measuring at specific processes may discourage shifts to more efficient technologies

Measurement Issues: Multiple Products

- Many products are commodities, traded using standard specifications
- Where single-product outputs are typical, metrics are easier to identify
 - » Btu per kWh
 - » Btu per ton of clinker
- But many industries produce multiple products, making the output metrics more complicated
 - » Forest products
 - » Petrochemicals
 - » Output mix varies widely from plant to plant
 - » What is the denominator? The benchmark?
- Revenues are rarely a good measure of output

Boundary Issues

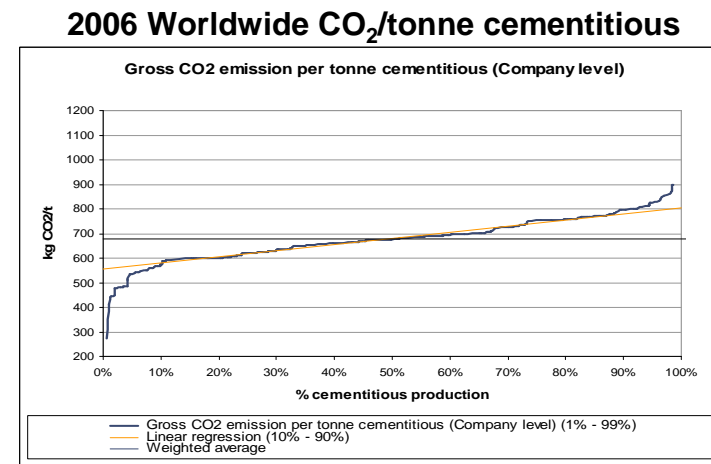
- Where we draw the measurement boundary, or “fence,” has important implications for sectoral agreements
 - » What we choose to measure (or not measure)
 - » All or some of direct use, indirect use, & process emissions?
 - » Energy use vs. emissions?
 - » How far to go “upstream”?
 - » How far to go “downstream”?
- Poor choices for boundaries and metrics can limit the potential benefits
 - » Attractive opportunities may be overlooked
 - » Good actions may be taken but not counted
 - » Unproductive activities may be rewarded
 - » “Gaming” opportunities can undermine confidence

Benchmarking

- Benchmarking is composed of two main elements:
 1. measurement protocols (*how & what to measure*)
 2. performance indicators and standards (*how to use the measures*)
- Benchmarking used in two primary ways:
 1. non-incentivized comparisons (passive)
 2. incentivized (rewards/penalties) systems (active)
- Primary goal for this study is the enumeration of performance indicators and standards.
 - » However, much more work has been done on measurement protocols than on performance metrics.
 - » In using existing industry efforts, we need to recognize limits in the scope of performance indicators and standards that can be developed.

Performance Indicators & Standards

- Goal: identifying & closing the “gap” between current efficiency and what could be achieved
- But these differences can reflect many things:
 - » Inefficiencies & opportunities for improvements
 - » Differences in process inputs
 - » Differences in output mix



The Challenge: How to identify the real opportunities?

- How to find the “right level” for benchmarks?
 - » Not too detailed for industry-wide agreements
 - » Not too simplified for plant-level operations

Cement: Illustrative Values

Reduction of fuel energy demand

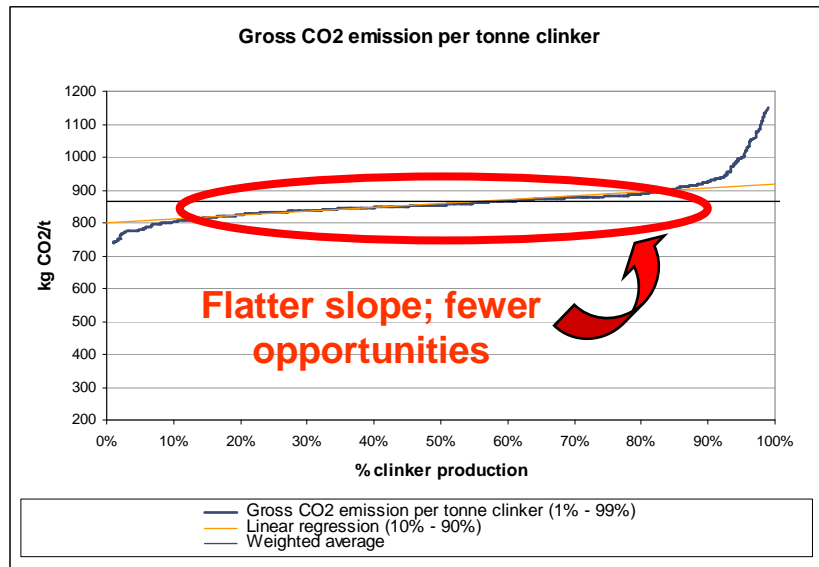
| | <u>Modernization of an "old" cement plant</u> | | <u>new "state of the art" cement plant</u> | |
|--------------------------------|---|------------------|--|---|
| | "Old" plant | Modernized plant | New plant | |
| Heat cons. | 1000 | 750 | 710 | Kcal/kg _{cli} |
| CO ₂ from raw meal | 0,27 | 0,27 | 0,27 | Nm ³ _{CO2} /kg _{cli} |
| CO ₂ from fuel | 0,2 | 0,15 | 0,14 | Nm ³ _{CO2} /kg _{cli} |
| Total CO ₂ Emission | 0,47 | 0,42 | 0,41 | Nm ³ _{CO2} /kg _{cli} |

Limited opportunities for kiln efficiency improvement

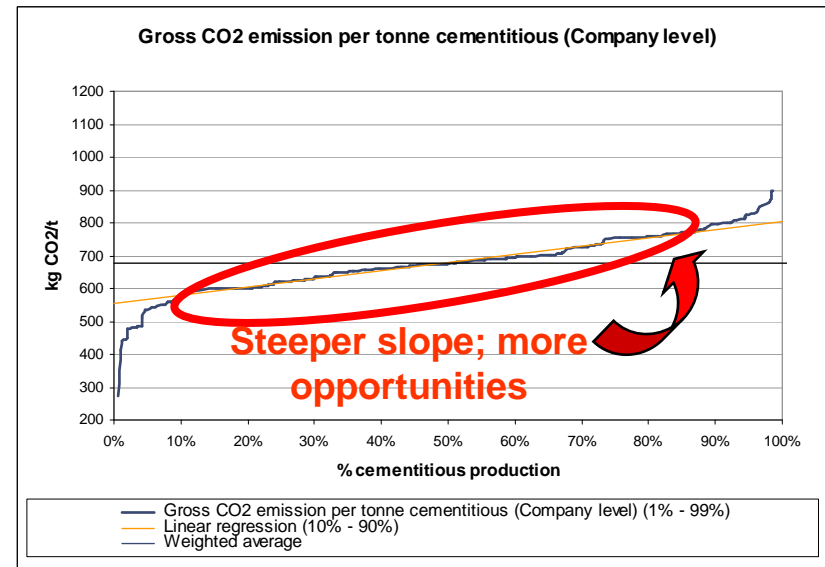
Source: Schurmann & Binniger, *CO₂ abatement possibilities in cement plants*, presented at the CSI Workshop, Washington DC, 19-May-2008.

Cement: Where are the Opportunities?

2006 Worldwide CO₂/tonne clinker



2006 Worldwide CO₂/tonne cementitious



Reflects:

- Kiln efficiency
- Fossil fuel mix
- Alternative fuel use

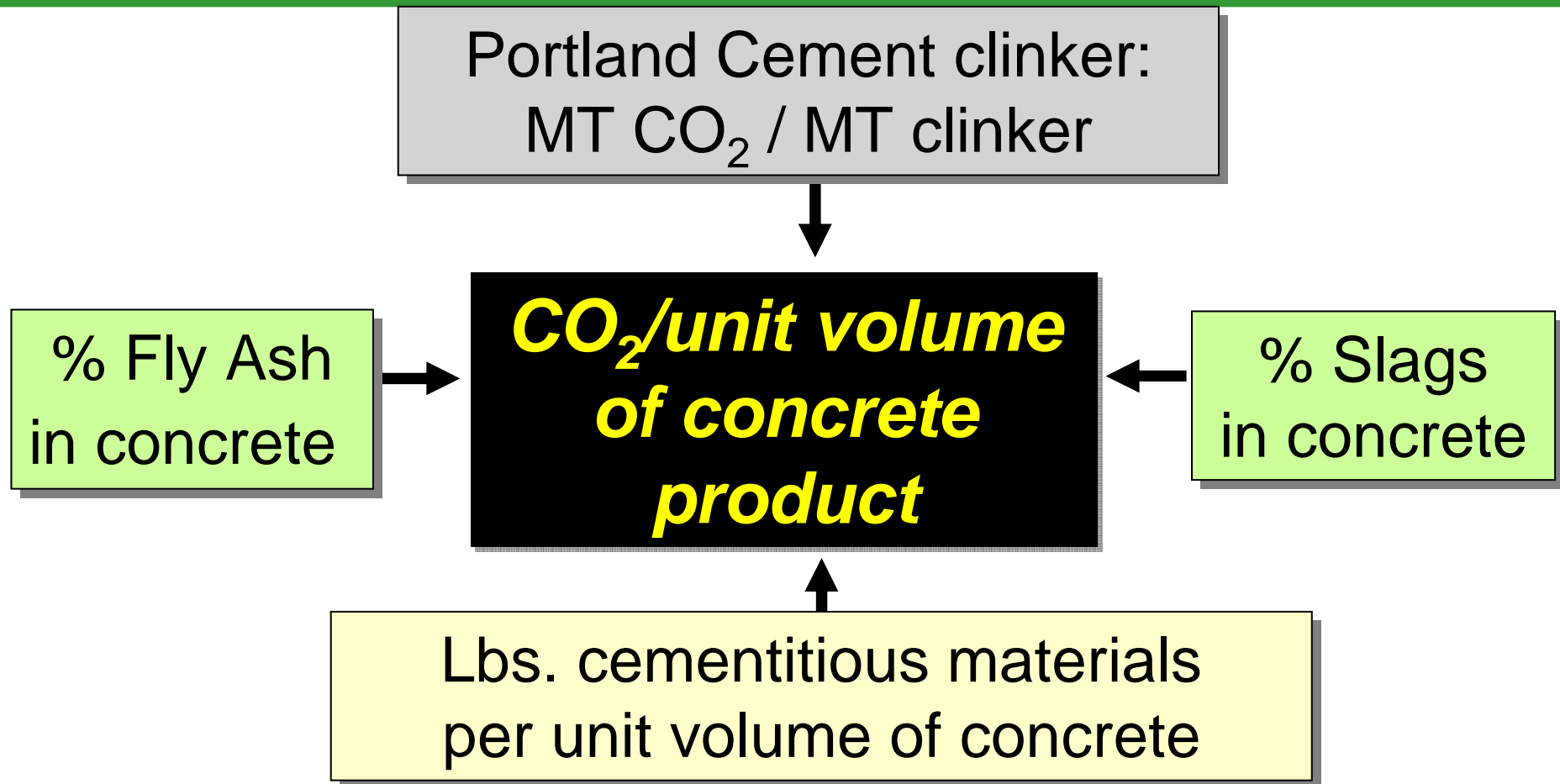
Also reflects:

- Flyash use
- Slag use

Source: Cement Sustainability Initiative, 2006 Survey results.

More opportunities when the boundaries are broader

Concrete's CO₂ Drivers



U.S. Cement & Concrete Intensity

Trends: 1990 to 2005

| <u>Variable</u> | <u>1990</u> | <u>2005</u> | <u>%</u> |
|--|-------------|-------------|----------|
| Portland Cement: MT CO ₂ /MT | 0.99 | 0.94 | -5% |
| % flyash & slag in concrete | 4% | 12% | +200% |
| Lbs. cementitious material per cubic yard concrete | 600 | 550 | -8% |
| MT CO ₂ per cubic yard concrete | .26 | .21 | -19% |
| Total MT CO ₂ output | 77 | 115 | +49% |

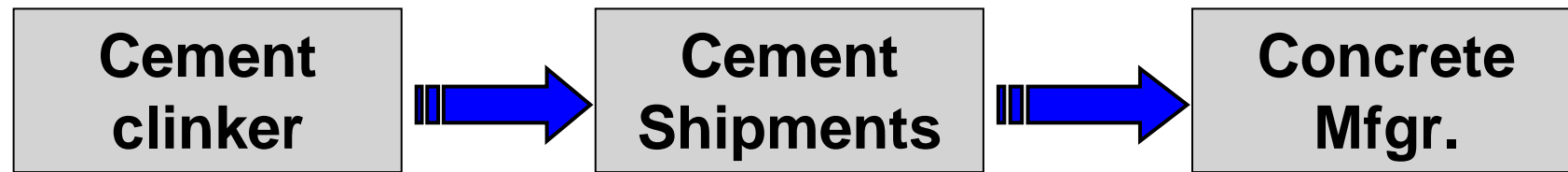


Kiln efficiency is only a part of overall intensity improvements!



Source: Adapted from Thomas M. Pounds, CalStar Cement, *Concrete Data: CO₂ from Cement and Concrete in the U.S., 1990 – 2050*, presented to American Coal Ash Association, 02-July-2008.

Effects of Different Measurement Boundaries



- Relatively easy to measure
- But misses opportunities for flyash & slag use

- Relatively easy to measure
- Captures flyash use, but only at the cement plant
 - Okay for most countries
 - Not okay for U.S.
- But misses effects of reducing cement use in concrete

- Captures more flyash use
- Greater range of efficiency measures
- Better comparison across int'l industry
- But harder to track
- Leakage for other cement uses

Cement: Measurement Issues

- Measure intensity using Btu, or GHGs?
- Measure output as clinker, or as cement?
- How to account for blended cements?
 - » Blended at the cement plants
 - » Blended in concrete manufacturing
- How to account for full-scale production sites vs. grinding & mixing operations?
- How to account for electricity use (indirect emissions)?
- Does co-generation create another “product”?
 - » Own use
 - » Sales into the grid

Measurement Issue: Btu or GHG?

- Question: Does a shift in demand get matched by similar supply increases?
 - » Or, do fuel markets shift?
- In Mexico, cement kilns shifted from fuel oil to pet coke. What if they switch to natural gas?
 - » Some global increase in natural gas production?
 - » Would global use of fuel oil & pet coke decline?
 - » Or, higher natural gas prices encourage more conservation?
 - » Or, might some gas users shift to coal?
- Net global GHG emissions may be higher or lower than changes at the end-user might suggest
- The effect is more pronounced when boundaries separate some countries and/or sectors
- Could Btu accounting give a clearer picture?

Measurement Issue: Life-Cycle accounting for fuel shifting?

- Natural gas has a clear GHG advantage at the burner tip
- But upstream emissions can narrow the savings:
 - » Higher upstream footprint for gas than for coal
 - » Higher still for LNG

Life-cycle GHG Emission Factors (units: lbs/MMBtu of Fuel Produced)

| Life-cycle Stages | North American NG | | LNG | | Coal | |
|---------------------|-------------------|------|------|------|------|------|
| | Min | Max | Min | Max | Min | Max |
| Upstream | 15.3 | 20.1 | 29.6 | 72.3 | 8.2 | 16.4 |
| Combustion (no CCS) | 120 | 120 | 120 | 120 | 205 | 205 |

Source: Jaramillo et al., CMU, *Comparative Life-cycle Emissions of Coal, Domestic Natural Gas, LNG, and SNG for Electricity Generation* (supporting information), 2007.

- Question: Can sectoral accounting create unhealthy incentives, esp. when boundaries are narrow?

Measurement Issue: How to account for indirect emissions?

- Electricity is a big energy input and source of emissions
- How to assign GHG emissions to electricity use?
 - » Exclude altogether? (leave it for the power companies)
 - » Specific source?
 - » System factor?
 - » National or regional factor?
 - » And for all, average vs. marginal?
- Would incentives change net behavior, or just shift activities?
- How to harmonize across multiple sectors?
- Possible guiding principle:
 - » Consumers can control how much power they use, but not how it is generated
 - » Generators can control the GHG intensity in the generation mix, but not how much power is demanded

Questions?

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