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Opportunities to Reduce GHGs Via Energy Efficiency: Lessons from Abroad

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Center for Clean Air Policy

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Center for Clean Air Policy (CCAP)

- Washington, CA, NY, Beijing and Brussels-based environmental think tank
- Committed to advancing pragmatic and cost-effective climate and air quality policy through analysis, dialogue, and education
- CCAP's 30-country climate policy dialogue produced agreements on emissions trading, design of Clean Development Mechanism; now focused on new climate treaty

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- Working with key developing countries (China, India, Brazil, Mexico) and U.S. states to design climate policies
  - » Sectors: electricity, cement, iron & steel, aluminum, oil (Mex)
- Completing major study for EC on sectoral approaches to reducing emissions from these sectors
- Original consultant on design of EU CO_2 emissions trading program and MRV system
- Running multi-stakeholder dialogues in the U.S. and the EU to build agreement on elements of a national climate policy package and EU strategy
- Help Members of Congress and governments worldwide consider and design policies

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Presentation Overview

- Review mitigation actions identified for energy intensive industry sectors in Mexico and China and discuss applicability to the US BACT context.
- Review carbon intensity benchmarks developed in Europe and applicability to the US BACT context.
- Draw preliminary lessons and identify some next steps.

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Context for Mitigation Actions Identified through Developing Country Sectoral Studies

- Development of baselines & mitigation cost curves to inform future commitments in key industrial sectors.
  - Not source-specific
- Seeking to inform how many reductions can be done unilaterally, which ones might qualify for international support, and which ones might earn offset credit.
- Also informing development of Nationally Appropriate Mitigation Actions, including design of cost-effective policy approaches.
- Bottom-up analyses looked at specific technologies.

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Caveats on Sectoral Study (Cement)

China study

- Contains "off-the-shelf" efficiency measures, but does not push the envelope on innovative technologies.
- Study does not reflect differences within industry sectors; a large number of SMEs with much lower technology level significantly drag down the sector-wide energy efficiency.
- Data quality not verified; data collection methods may differ due to capacity limits.

Mexico study

- Cement study is based on data from CEMEX, which owns relatively clean installations.
  - Actual reduction potential could be greater than indicated.
- For energy/electricity use and blending, had data on individual installations for one year. All Mx kilns are dry kilns.

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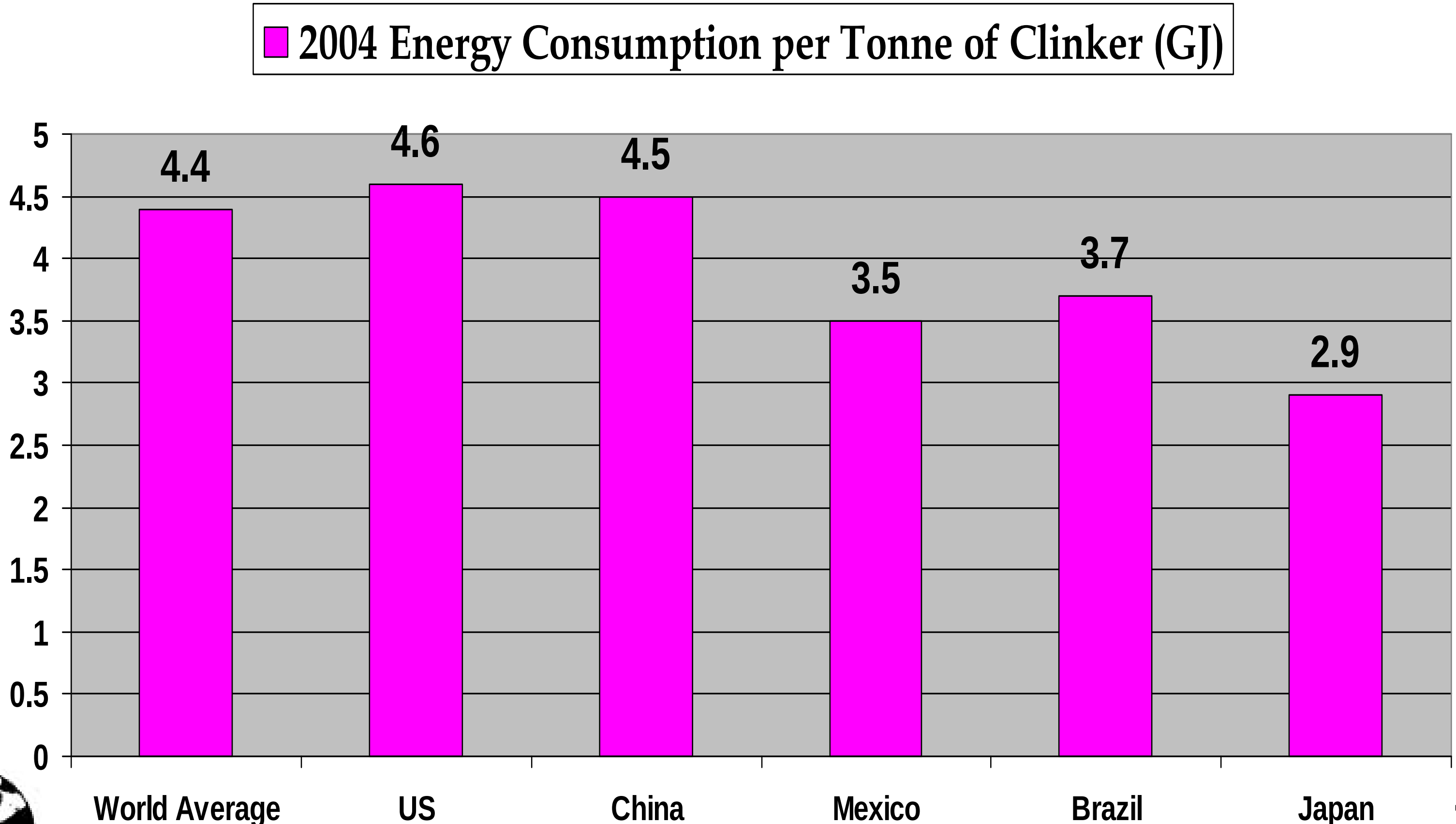
Relative Efficiency of Cement Industry in Select Countries

US cement sector is on par with China, less efficient than Mexico.



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Source: IEA. 2008. Worldwide Trends in Energy Use and Efficiency

Cement Sector: CCAP Analysis of Mitigation Options (China, 2015)

No.	Measures	Marginal mitigation cost ($/t$CO_2$)	Total Emission Reduction (Mt CO_2)
1	Process control systems	-5.2	25.1
2	Use of waste fuels(d)	-4.6	34.8
3	Blended cement	-3.4	54.3
4	Kiln shell heat loss reduction(d)	-2.2	11.6
5	Kiln shell heat loss reduction(w)	-1.5	0
6	Optimize heat recovery(grate cooler)(d)	-0.8	7.7
7	Optimize heat recovery(grate cooler)(w)	0	0
8	High-efficiency motors	0.8	2.4
9	Conversion to grate cooler(w)	1.6	0.1
10	Conversion to semi-wet process(w)	2.4	0.3

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Cement Sector: CCAP Analysis of Mitigation Options (China, 2015)

No.	Measures	Marginal mitigation cost ($/tCO_2$)	Total Emission Reduction (Mt CO_2)
11	Conversion to grate cooler(d)	3.2	24.7
12	Kiln combustion systems(w)	4	0.1
13	Kiln combustion systems(d)	4.8	13.3
14	Conversion to PH/PC-kiln(d)	5.1	19.8
15	Conversion to pre-calciner kiln(d)	5.4	6.1
16	Conversion to multi-stage preheating(d)	5.7	13.7
17	Conversion to precalciner kiln(w)	6.3	0.7
18	Roller press/Horomill	6.9	10.9
19	Variable speed drives	7.5	4.2
20	Low pressure-drop cyclones(d)	8.1	1.1

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Cement Sector: CCAP Analysis of Mitigation Options (China, 2015)

No.	Measures	Marginal mitigation cost ($/t$CO_2$)	Total Emission Reduction (Mt CO_2)
21	Heat recovery for power generation(d)	8.7	5.6
22	High efficiency roller mills(d)	9.2	5.5
23	High-pressure roller press	10.3	3.2
24	Improved grinding media	11.3	0.8
25	High efficiency classifiers(final)	12.3	1.2
26	High efficiency classifiers(d)	13.3	2.1
27	Mechanical transport systems(w)	15.2	0
28	Mechanical transport system(d)	17.1	1.6
29	Raw meal blending system(d)	19.3	0.8
30	Use of waste fuels(w)	21.7	0

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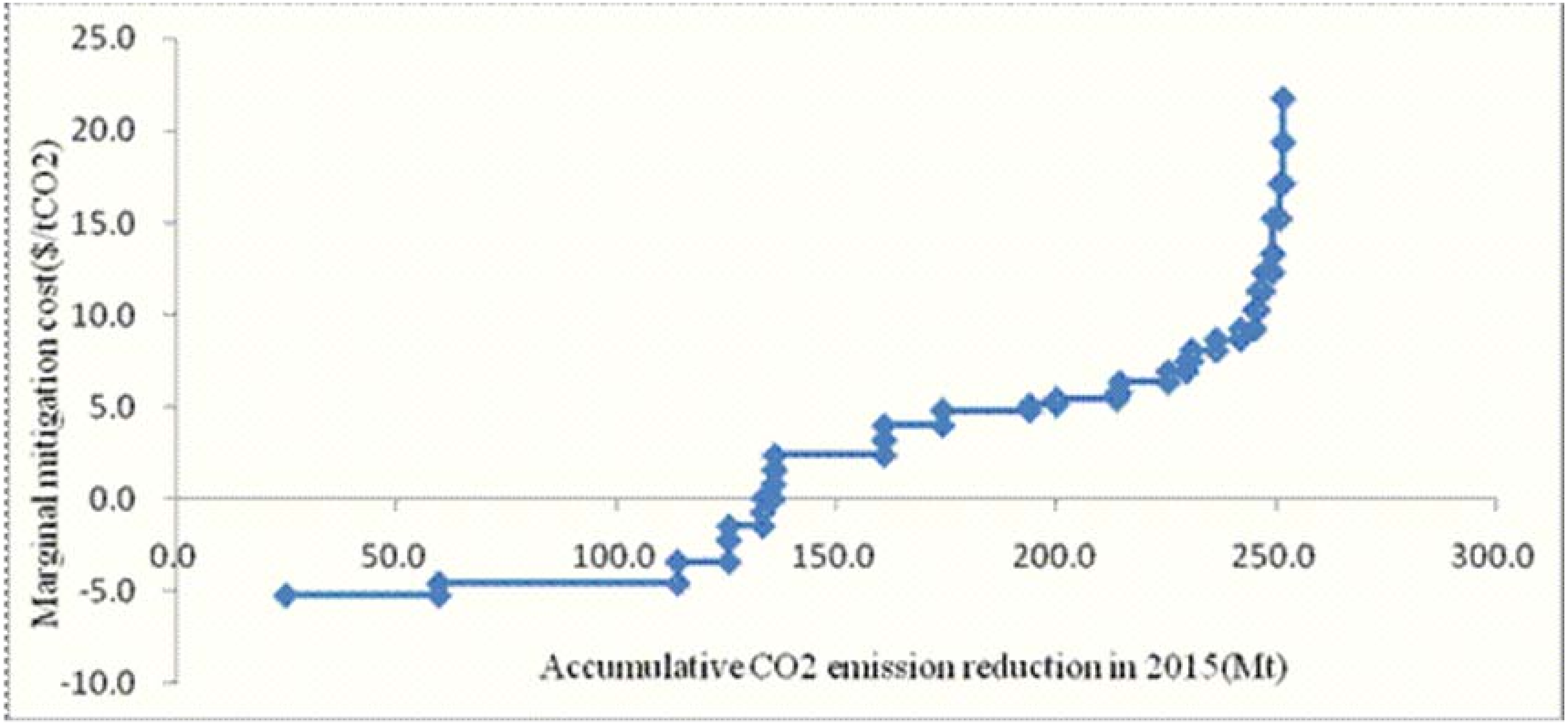
China Cement Cost Curve (2015)



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Cement Sector: CCAP Analysis of Mitigation Options (Mexico)

	Emissions Reduction Potentials	Emissions	Redux	Redux	Emissions Intensity
No.	2020 Scenario	MtCO2	MtCO2	%	tCO2 / t cement
0	Baseline (BAU)	41.63	0.00	0.0%	0.737
1	Max. EE = 3 GJ/t clinker	39.54	2.09	5.0%	0.700
2	Blending = 72.3%	37.87	3.76	9.0%	0.671
3	Buy RE electricity/offsets	38.15	3.48	8.4%	0.676
4	Alt fuels (tires) = 30%	41.05	0.58	1.4%	0.727
5	Alt fuels (MSW) = 30%	39.17	2.46	5.9%	0.694
6	Alt fuels (sludge) = 30%	36.97	4.66	11.2%	0.655
7	Electricity Intensity = 80 KWh/t cement	40.52	1.11	2.7%	0.718

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Feedback from CANACEM

- **Energy Efficiency:**
  - » Can't physically retrofit to this efficiency
  - » Specific conditions prevent some upgrades
  - » Implementation cost is very high ($1.9 billion)
- **Blending:**
  - » Inexpensive way to reduce emissions
  - » Need new NOMs for cement and market support to ensure demand
  - » Slag/fly ash supplies limited but pozzolans prevalent in some areas
  - » Cost may be underestimated and implementation scenario is unrealistic
- **Purchase of Renewable Electricity:**
  - » Cement sector shouldn't be responsible for indirect emissions
- **Alternative Fuels:**
  - » Very promising option (MSW and sludge have high biomass content)
  - » barriers are significant
- **Electricity intensity:**
  - » Mitigation scenario is infeasible

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Promising Cement Sector Mitigation Options – Conclusions (Mexico)

- Cement blending
  - Barriers include market limits (supply of blending materials?)
  - Full implementation cost could be much higher than original estimate (more than $600 million (2012 USD) over 20 years)
- Use of alternative fuels
  - Primary barriers are legal/regulatory + fuel processing costs
  - Full implementation cost depends upon choice of alternative fuel and relative prices of alternative fuel vs. petcoke
- Replacement of fossil-fuel electricity with renewable electricity built by cement industry (expanded cement sector boundary)
  - Depends on how the power sector is included in mitigation efforts

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Thoughts on Applicability of Cement Sector Analysis for the United States

- Many specific efficiency measures have been identified, some at a low cost per ton.
  - » This is particularly the case for China, which has efficiency levels closer to the U.S.
- Focusing on just efficiency leaves a lot on the table.
- Efficiency measures at existing plants may require high up front investment (and for cement, long paybacks).
  - » How is payback considered in BACT cost analysis?
- Efficiency improvements can be applied more easily to new units than to existing units.
- Cement blending a good option in Mexico/China, but may not reduce emissions from cement plants in the U.S. as blending occurs closer to point of use.

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Context for European Benchmarking

- Under Phase III of EUETS, allowance allocations to carbon intensive, trade-exposed industries/products are based on benchmarks.
  - » Benchmarks set at the average of the top 10% for a given product category, regardless of the process type or fuel.
  - » Benchmarks reflect the combination of processes/fuels/ efficiency measures in place at top-performing units, without regard to cost.
- Sources may purchase allowances or offsets to cover annual emissions in excess of their annual allocations – system does not set binding unit-specific standards
- Limited detail available on specific technologies and efficiency measures at top performing units – competitive concerns
- Based on unit-specific emissions and output data.

Sector Definition – Proposed Cement Sector Benchmark Based on Clinker

- Practical difficulties in setting a cement benchmark, in particular:
  - » Cement benchmarking cannot be applied to individual installations due to the trade of clinker between installations including trade with grinding stations.
  - » With cement benchmarking, it becomes necessary to account for the differentiated availability of clinker substitutes and quality differences between blended cements.

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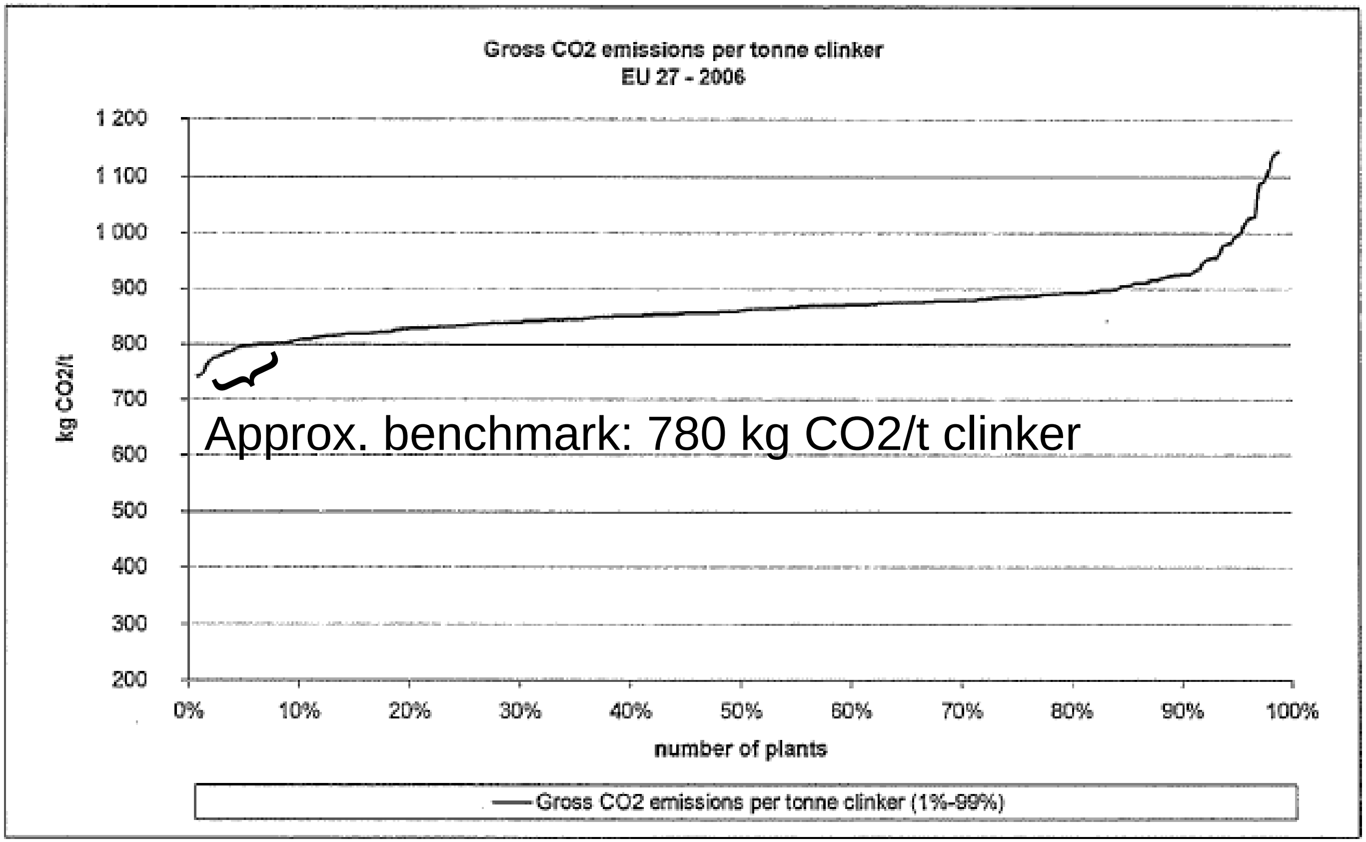
European Benchmarking of the Cement Industry



Formula of the linear regression between 10% and 90%: y= 1,17 x + 802

US average = 934 kg CO2/ton

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Benchmarking Implementation

- Average performance of 10% most efficient installations in (sub)sector calculated for products.
- 50-57 benchmarks under development for 19 sectors, 35-41 benchmarks being based on benchmark curves, remainder based on best available technology & samples.
- EU considering "innovation accelerator" to encourage laggards to make large EE improvements
- Benchmark curves cover ~80% of the emissions.
- Consultative and transparent process. For proposed benchmarks and related documents see: http://ec.europa.eu/environment/climat/emission/benchmarking_en.htm

European Benchmarks

- Aluminum
- Cement
- Ceramics
- Chemicals
- Glass
- Gypsum
- Iron & Steel
- Iron Ore
- Lime
- Mineral Wool
- Non-ferrous metals
- Pulp & Paper
- Refining
- Heat production benchmark
  (for combustion of fuel for production of hot water/steam)
- Fuel mix benchmark
  (where the heat produced is not measured--furnaces)

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Thoughts on Applicability of European Benchmark for United States BACT

Europe

- No separate data on technologies used in top performing plants (competitive concerns).
  - » Benchmark factors in process, fuels & efficiency.
- One benchmark covers all facilities producing a given product.
  - » Costs and regional/source-specific issues not considered.
  - » Sources can always buy allowances/offsets.

United States BACT

- Data on individual technologies generally used to define BACT.
  - » Could develop standards/benchmarks reflecting actual available technology combinations.
- Standard is source-specific, considering energy, environmental & other costs.
  - » NSPS, if any, provides floor.
  - » No precedent for compliance via offsets, but possible?

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Next Steps

- What is the boundary for BACT analysis?
  - Include blending?
  - Include indirect emissions?
  - For an existing source, include the whole source, or just the narrow modification?
- Can benchmarks be used to define BACT?
  - Is there precedent for a broader performance std approach? Via NSPS floor?
  - What are the pros/cons for new/existing source modifications?
  - Legal justification for use of offsets?
  - Is there any opportunity for building in EE incentives?

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