
Industrial Benchmarking for Sectoral Approaches

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Cement: Benchmarking

- Benchmarking and Energy Saving Tool (BEST) Cement for China
 - » developed by Lawrence Berkeley National Laboratory, together with Energy Research Institute, China Cement Association, China Building Materials Academy, and Shandong University
 - » a self assessment tool to be used by cement plants in benchmarking their energy use against best practice levels and evaluating the impact of selected energy efficiency measures
 - » focuses only on the energy performance aspect of cement production. It does not calculate GHG emissions
- Cement Sustainability Initiative (CSI) database
 - » Global database (less information at present for China)
 - » Energy use and emissions

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}

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

Cement: Best Practices

World Best Practice Final Energy Intensity for Cement (GJ/tonne)

	Portland Cement 5% Additives			Cement 25% Fly Ash			Cement - 65% Blast Furnace Slag		
	Electricity	Fuel	Final Energy	Electricity	Fuel	Final Energy	Electricity	Fuel	Final Energy
Raw Materials Preparation	0.07		0.07	0.05		0.05	0.03		0.03
Solid Fuels Preparation	<.005		<.005	<.005		<.005	<.005		<.005
Clinker Making	0.08	2.71	2.79	0.05	1.90	1.95	0.03	1.00	1.03
Additives Preparation			0	0.03		0.03	0.09	0.45	0.54
Finish Grinding:325 Cement	0.06		0.06	0.08		0.08	0.15		0.15
Total: 325 Cement	0.21	2.71	2.92	0.21	1.90	2.11	0.30	1.45	1.75

Cement: Issues

- Need to distinguish by process type (wet vs. dry process?)
- Measure output as clinker, or as cement?
- How to account for full-scale production sites vs. grinding & mixing operations?
- Would co-generation create another “product”?
- How to account for blended cements
 - » Blended at the cement plants
 - » Blended in concrete manufacturing

Electricity: Benchmarking

- Asia-Pacific Partnership on Clean Development & Climate
 - » Power sector task forces:
 - Cleaner Fossil Energy
 - Power Generation & Transmission
 - Renewable Energy & Distributed Generation
 - » Activities under way:
 - Sharing Best Practices in Cleaner Fossil Energy
 - Comparison of Power Efficiency on Grid Level
(Benchmarking Energy Efficiency)
 - Best Practices in Indian Thermal Power Generation Units

Electricity: Illustrative Values

Cost and Performance Characteristics of New Central Station Electricity Generating Technologies

Technology	Online Year ¹	Size (mW)	Heatrate ⁶ in 2007 (Btu/kWhr)	Heatrate nth-of-a-kind (Btu/kWhr)
Scrubbed Coal New ⁷	2011	600	9,200	8,740
Integrated Coal-Gasification Combined Cycle (IGCC) ⁷	2011	550	8,765	7,450
IGCC with Carbon Sequestration	2011	380	10,781	8,307
Conv Gas/Oil Comb Cycle	2010	250	7,196	6,800
Adv Gas/Oil Comb Cycle (CC)	2010	400	6,752	6,333
ADV CC with Carbon Sequestration	2010	400	8,613	7,493
Conv Combustion Turbine ⁸	2009	160	10,833	10,450
Adv Combustion Turbine	2009	230	9,289	8,550
Fuel Cells	2010	10	7,930	6,960



Source: U.S. Dept. of Energy, Energy Information Administration, *Assumptions to the Annual Energy Outlook 2008*, Table 38, page 79, February 2009.

Electricity: Issues

- Distinguish by fuel type?
 - » Coal (further categorized by coal rank?)
 - » Natural gas
 - » Nuclear & renewables
- Distinguish by equipment type?
 - » Supercritical
 - » USC
 - » IGCC
- Does point of measurement change incentives for fuel switching?

Iron & Steel: Benchmarking

- International Iron and Steel Institute (IISI) database
 - » IISI's climate change policy is aimed at reducing CO2 emissions worldwide through a global steel sector approach.
 - » The core of the approach is collection & reporting of CO2 emissions data by steel plants in all major steel producing countries.
 - » The information will lead to benchmarking improvements based on actual performance data, then reporting and setting of commitments on a national or regional basis for post-2012 implementation.
 - » Phase 1 of the global sectoral approach to climate change for the steel industry -- the design and testing of a globally consistent calculation methodology -- has been completed.
 - » As of April 2008, Phase 2, a specially commissioned secure website is now available to collect emissions data from all steel plants worldwide.

Iron & Steel: Illustrative Results

Process breakdown and energy intensities as used in BEST to benchmark iron and steel plants

Process	Fuel (GJ/ton)	Steam (GJ/ton)	Electricity (GJe/ton)	Oxygen (Nm ³ /ton)
Coke plant	1.76	0.29	0.11	0
Sinter plant	1.43	-0.16	0.11	0
Pellet plant	0.66	0.00	0.14	0
Blast Furnace	11.53	0.40	0.09	35
Basic Oxygen Furnace	0.09	-0.15	0.09	52
Electric Arc Furnace	0.54	0.00	1.47	37
Refining	0.00	0.00	0.13	0
Casting – slab	0.03	0.00	0.03	0
Casting – billet	0.03	0.00	0.03	0
Hot rolling – plate	1.08	0.00	0.29	0
Hot rolling – strip	1.25	0.02	0.28	0
Hot rolling - bar	1.50	0.00	0.25	0
Hot rolling – wire	1.60	0.00	0.38	0
Cold rolling	0.05	0.09	0.26	0
Finishing	0.73	0.26	0.13	0

Iron & Steel: Issues

- BOF vs. electric arc furnaces
 - » Separate benchmarks?
 - » How to encourage more scrap use?
- Product outputs
 - » How to account for multiple products?
 - » How to account for changing product mix?
- Variations in industry structure
 - » How to account for activities when degree of vertical integration differs?
 - » How to account for upstream activities?
 - » How to account for dedicated infrastructure?

Aluminum: Benchmarking

- International Aluminium Association (IAI) statistics & reporting on voluntary objectives
 - » IAI collects energy use and PFC emissions data
 - » using the IAI/GHG Protocol measurement protocol and tool
- Aluminium for Future Generations Sustainable Development Programme
 - » launched in 2003, currently comprises 13 voluntary objectives and 22 performance indicators
 - » An IAI team of technical experts provides advice and training on good practice around the world.

Aluminum: Illustrative Results

World Averages: Energy Inputs for 1000 kg in Primary Aluminium Production

Process	Bauxite Mining	Alumina Production	Anode Production	Electrolysis	Casthouse	Total	Units
Fuels and electricity							
Coal		170	1,0		1,2	173	kg
Diesel Oil	6,0	1,3	1,0		1,4	9,7	kg
Heavy Oil	1,3	195	4,9		5,7	207	kg
Natural Gas	0,002	223	23		30	277	m ³
Electricity	10	242	56	15289	83	15680	kWh

Aluminum: Issues

- How to measure indirect emissions from electricity use?
 - » Specific contract or local supply?
 - » Regional or national averages?
 - » Global averages?
- Quality and accuracy of PFC emission measurement
- Other direct and process emissions