BEST Cement for China —Benchmarking and Energy Savings Tool

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Outline

1. Introduction

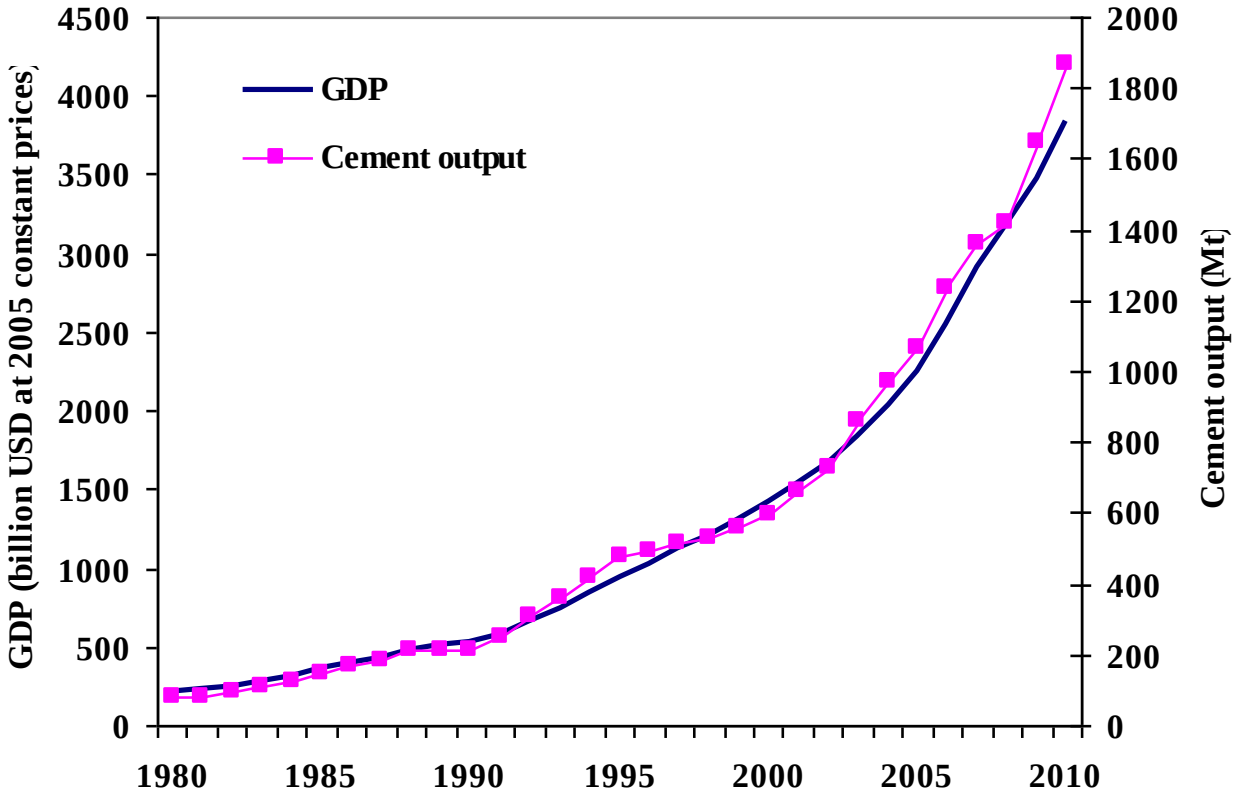
2. Process-based benchmarking

3. Workflow of BEST Cement

1. Introduction

—What is BEST Cement for China?

Cement production in China



China's gross domestic product (GDP) and cement output, 1980-2010
Source: NBS (various years), CCA (various years).

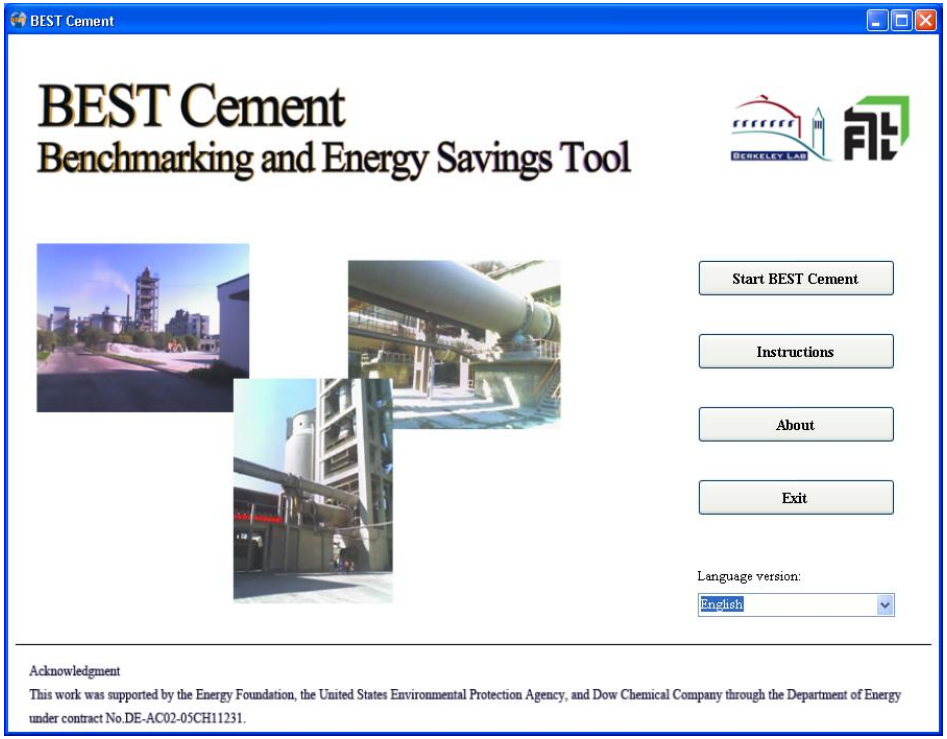
CO_2 emissions from China's cement production

Estimation of CO_2 emissions from China's cement production in 2005-2009

Source: Ke et al. (2012).

Year	2005	2006	2007	2008	2009
Clinker output (Mt)	779.0	873.3	956.7	977.0	1084.0
Cement process CO_2 emissions (Mt CO_2)	426.0	477.6	523.2	534.3	592.9
Cement output (Mt)	1068.9	1236.1	1361.2	1420.1	1648.6
Emissions from fossil fuel combustion (Mt CO_2)	347.8	381.2	393.3	399.1	437.6
Direct emissions (Mt CO_2)	**773.8**	**858.8**	**916.5**	**933.5**	**1030.5**
Consumed electricity from external power generation (TWh)	105.05	116.73	123.40	122.06	126.96
Emissions from external electricity production (Mt CO_2)	87.6	97.5	100.3	93.2	95.9
Clinker-to-cement ratio (%)	72.9	70.6	70.3	68.8	65.8
Total emissions (Mt CO_2)	861.4	956.3	1016.8	1026.6	1126.4

BEST Cement for China



BEST Cement:

- process-based benchmarking and energy savings tool
- based on commercially-available efficiency technologies used worldwide
- applicable to the cement industry
- designed for use in China

BEST Cement for China has been developed by Lawrence Berkeley National Laboratory in collaboration with the Energy Research Institute, the China Cement Association, the China Building Materials Academy, and Shandong University with financial support of the U.S. Environmental Protection Agency, Energy Foundation, and Dow Chemical Company.

Selecting Benchmarking

- **Entire facility or kiln?**

Up to 6 kilns for entire facility.

- **Quick assessment or detailed assessment?**

This choice will determine the level of detail of the energy input. The detailed assessment will require energy data for each stage of production while the quick assessment will require only total energy used at the entire facility.

- **Chinese best practices or international best practices?**

BEST Cement provides two benchmarks - one for Chinese best practices and one for international best practices.

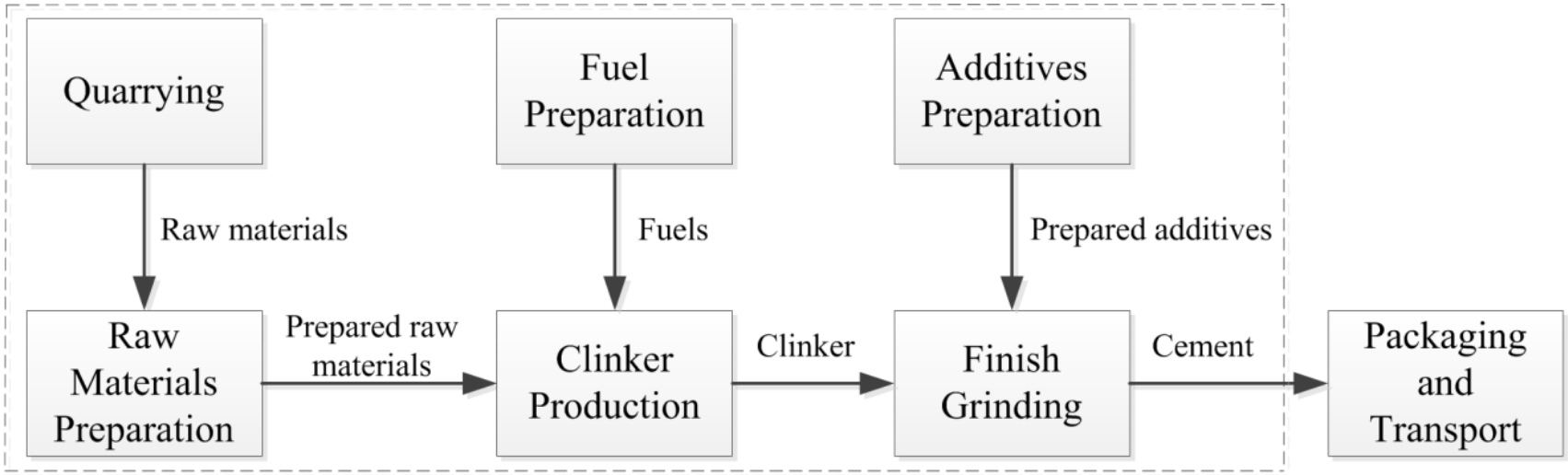
- **Best practices or national standard?**

BEST Cement can also benchmark the cement facility against the Chinese national standard for cement production.

2. Process-based benchmarking

– Top-down decomposition and modular analysis

Overview of cement production process



Overview of cement production process

Note: Dashed lines outline the processes addressed in BEST Cement benchmarking tool

Processes addressed in BEST Cement for benchmarking a cement facility

Process blocks	Process-steps
• Raw materials preparation	• Preblending (prehomogenization, proportioning and reclaiming) • Crushing • Grinding • Homogenization
• Fuel preparation	• Fuel grinding and preparation
• Additives preparation	• Additive grinding and blending • Drying
• Kiln system - machinery use (electricity)	• Preheater & clinker cooler • Precalciners & kiln
• Kiln system - clinker making (fuel use)	• Precalciners • kiln
• Cement grinding	• Grinding by cement types and grades
• Other production energy	• Quarrying • Auxiliaries • Conveyors
• Other non-production energy	• Lighting, office equipment, miscellaneous

Benchmark

- No actual cement facility with every single efficiency measure included in the benchmark will likely exist, however, the benchmark sets a reasonable standard by which to compare.
- The energy consumption of the benchmark facility will differ due to differences in processing at a given cement enterprise.
- The tool accounts for these variables and allows the user to adapt the model to operational variables specific for their cement facility.

3. Workflow of BEST Cement

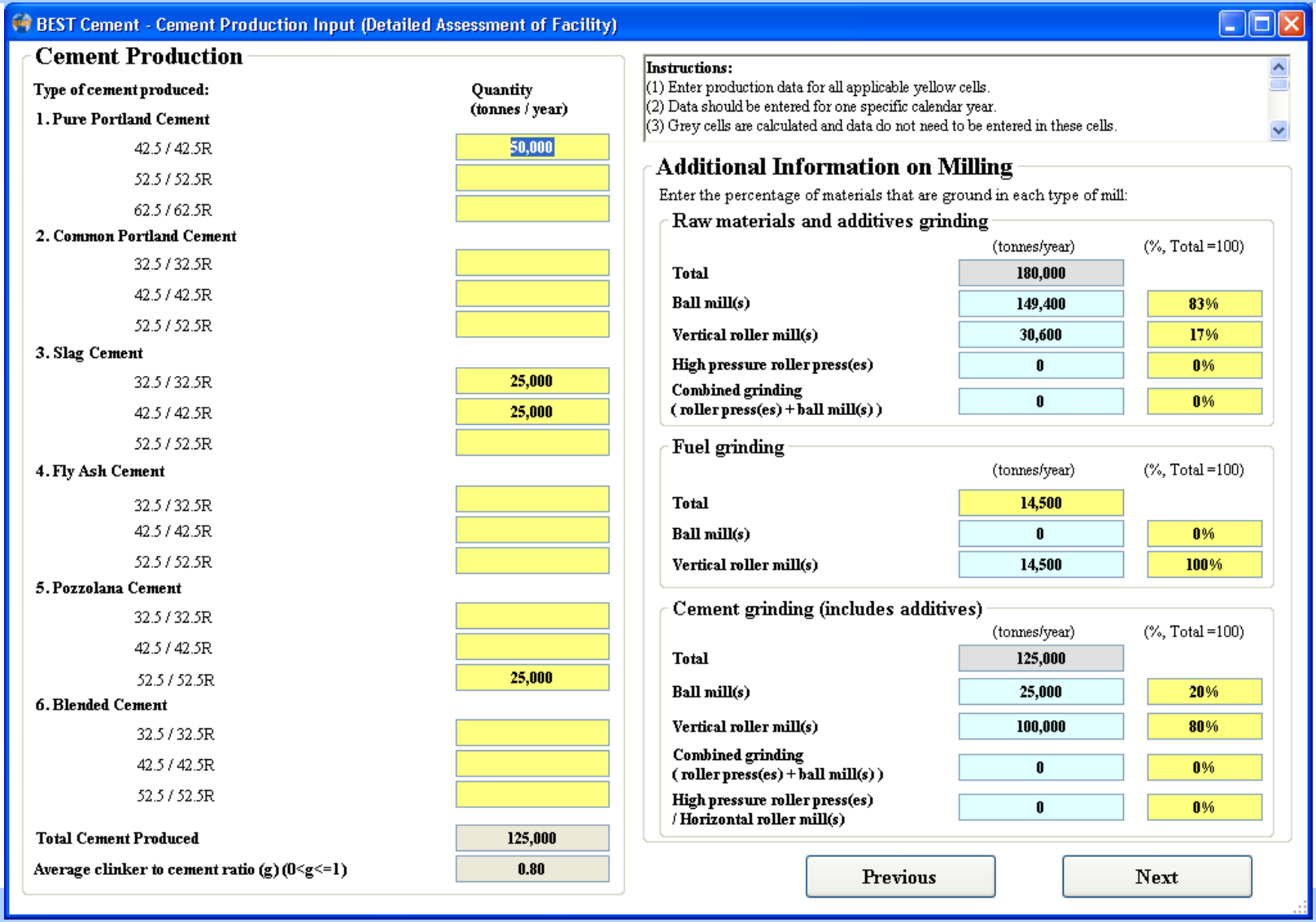
Input

Major production variables required include:

- **the amount of raw materials used**
- **the amount of raw materials that are prehomogenized and proportioned**
- **the amount of additives that are dried and ground**
- **the production of clinker from each kiln by kiln type**
- **the amount of production of cement by type and grade**
- **the energy used by fuel type and process**

Information such as milling and electricity generation is also required.

Input – Cement production



BEST Cement - Cement Production Input (Detailed Assessment of Facility)

Cement Production

Type of cement produced:	Quantity (tonnes / year)
1. Pure Portland Cement	
42.5 / 42.5R	50,000
52.5 / 52.5R	
62.5 / 62.5R	
2. Common Portland Cement	
32.5 / 32.5R	
42.5 / 42.5R	
52.5 / 52.5R	
3. Slag Cement	
32.5 / 32.5R	25,000
42.5 / 42.5R	25,000
52.5 / 52.5R	
4. Fly Ash Cement	
32.5 / 32.5R	
42.5 / 42.5R	
52.5 / 52.5R	
5. Pozzolana Cement	
32.5 / 32.5R	
42.5 / 42.5R	
52.5 / 52.5R	25,000
6. Blended Cement	
32.5 / 32.5R	
42.5 / 42.5R	
52.5 / 52.5R	
Total Cement Produced	125,000
Average clinker to cement ratio (g) (0<g<=1)	0.80

Instructions:
(1) Enter production data for all applicable yellow cells.
(2) Data should be entered for one specific calendar year.
(3) Grey cells are calculated and data do not need to be entered in these cells.

Additional Information on Milling

Enter the percentage of materials that are ground in each type of mill:

Raw materials and additives grinding

	(tonnes/year)	(%, Total =100)
Total	180,000	
Ball mill(s)	149,400	83%
Vertical roller mill(s)	30,600	17%
High pressure roller press(es)	0	0%
Combined grinding (roller press(es) + ball mill(s))	0	0%

Fuel grinding

	(tonnes/year)	(%, Total =100)
Total	14,500	
Ball mill(s)	0	0%
Vertical roller mill(s)	14,500	100%

Cement grinding (includes additives)

	(tonnes/year)	(%, Total =100)
Total	125,000	
Ball mill(s)	25,000	20%
Vertical roller mill(s)	100,000	80%
Combined grinding (roller press(es) + ball mill(s))	0	0%
High pressure roller press(es) / Horizontal roller mill(s)	0	0%

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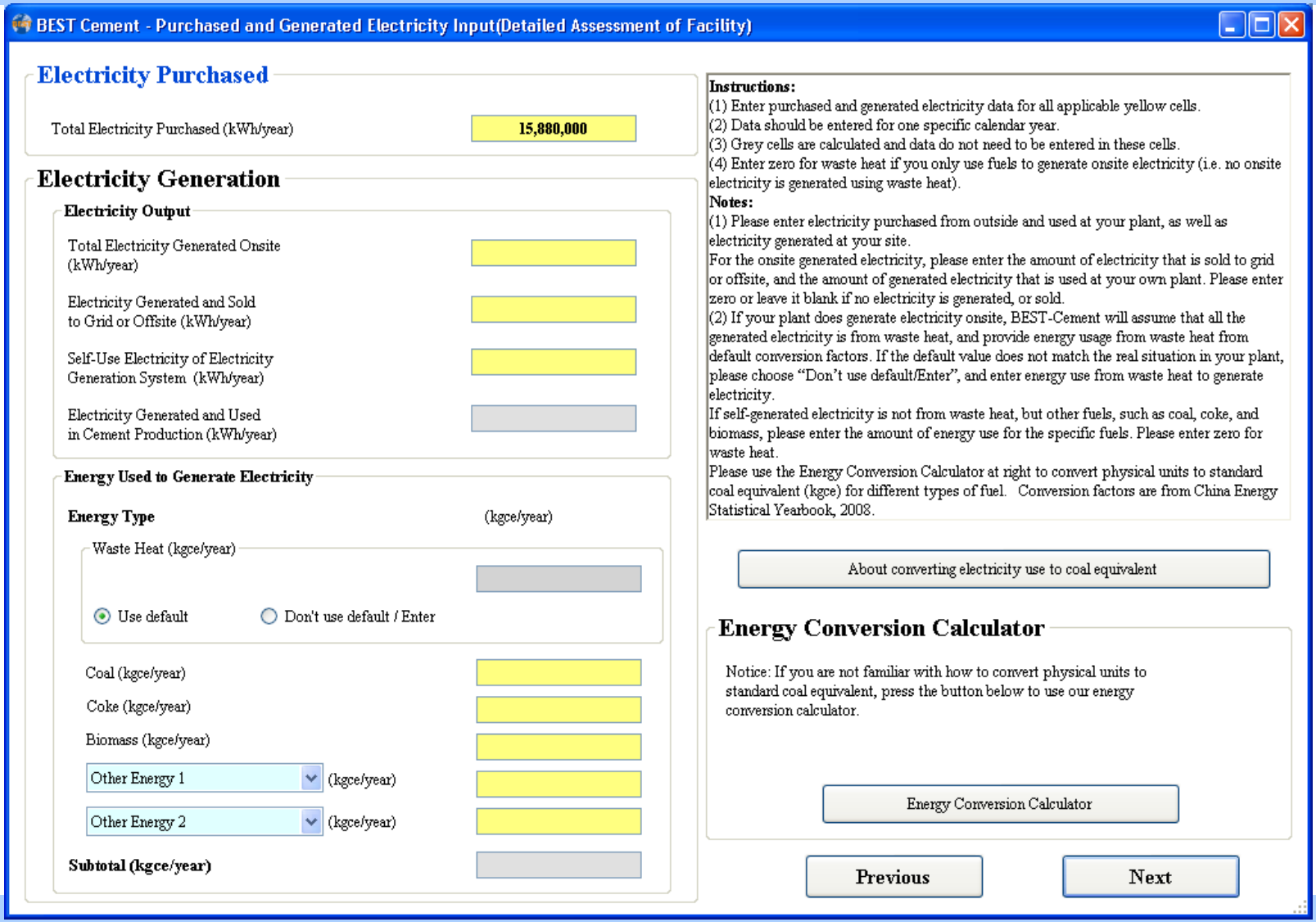
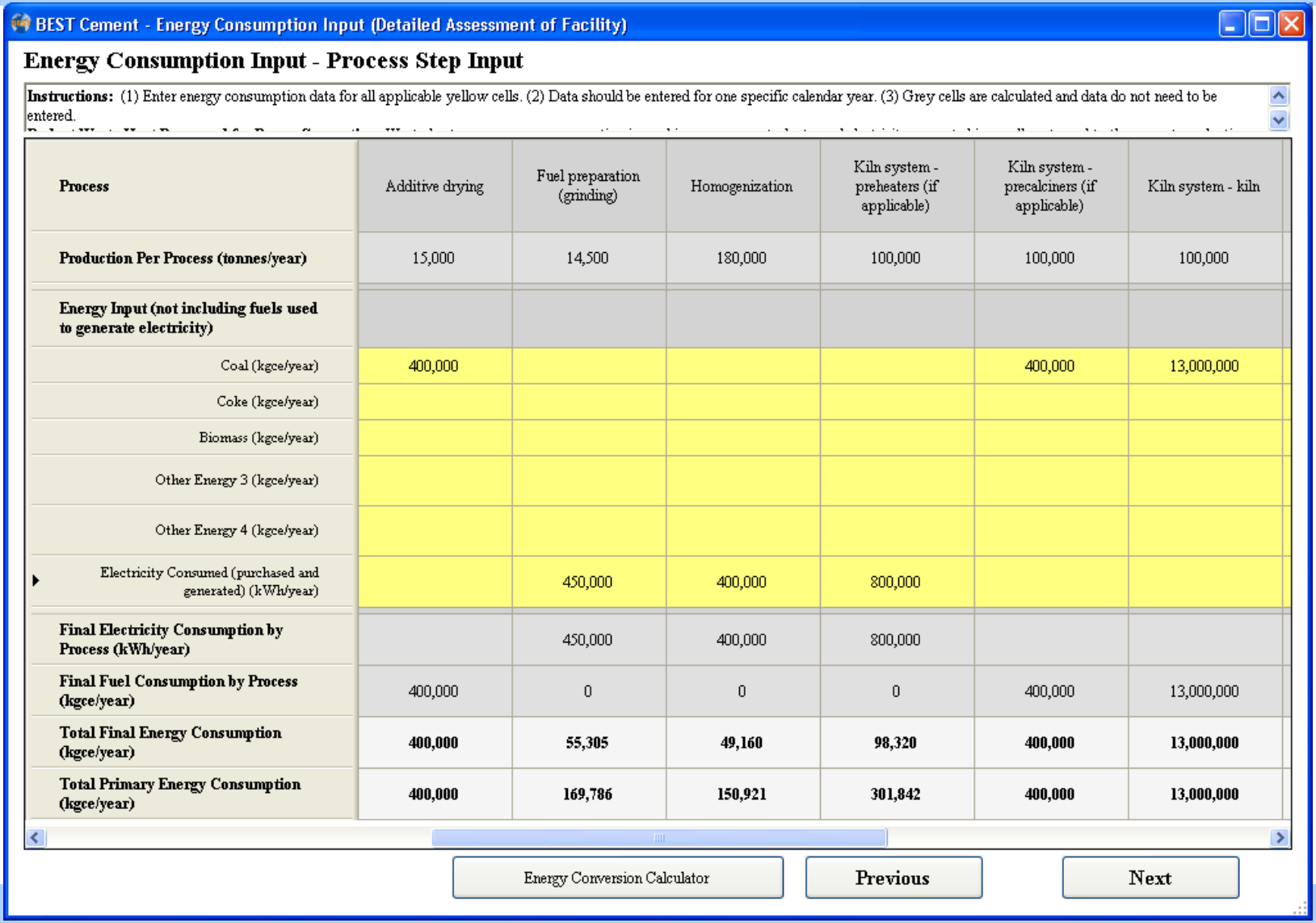
Input — Electricity generation



Input – Energy consumption by process step



BEST Cement - Energy Consumption Input (Detailed Assessment of Facility)

Energy Consumption Input - Process Step Input

Instructions: (1) Enter energy consumption data for all applicable yellow cells. (2) Data should be entered for one specific calendar year. (3) Grey cells are calculated and data do not need to be entered.

Process	Additive drying	Fuel preparation (grinding)	Homogenization	Kiln system - preheaters (if applicable)	Kiln system - precalciners (if applicable)	Kiln system - kiln
Production Per Process (tonnes/year)	15,000	14,500	180,000	100,000	100,000	100,000
Energy Input (not including fuels used to generate electricity)						
Coal (kgce/year)	400,000				400,000	13,000,000
Coke (kgce/year)						
Biomass (kgce/year)						
Other Energy 3 (kgce/year)						
Other Energy 4 (kgce/year)						
Electricity Consumed (purchased and generated) (kWh/year)		450,000	400,000	800,000		
Final Electricity Consumption by Process (kWh/year)		450,000	400,000	800,000		
Final Fuel Consumption by Process (kgce/year)	400,000	0	0	0	400,000	13,000,000
Total Final Energy Consumption (kgce/year)	**400,000**	**55,305**	**49,160**	**98,320**	**400,000**	**13,000,000**
Total Primary Energy Consumption (kgce/year)	**400,000**	**169,786**	**150,921**	**301,842**	**400,000**	**13,000,000**

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Benchmarking

- Energy intensity

- Energy Intensity Index (EII)

- Benchmarking is used to

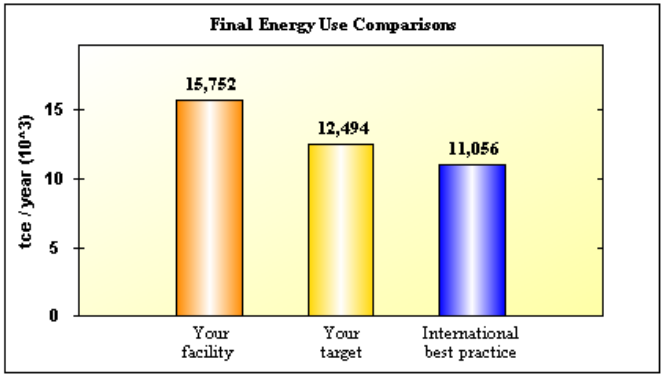
(1) evaluate the energy efficiency of the user's cement facility;

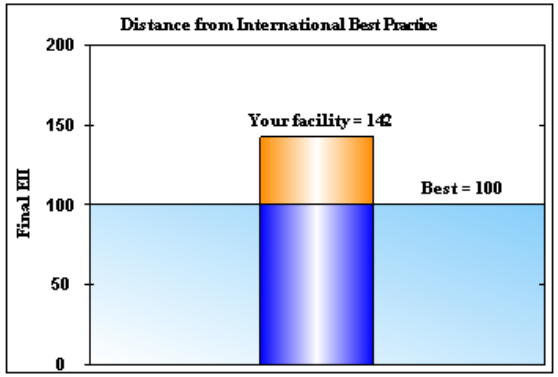
(2) identify the potential for improving energy efficiency.

International benchmarking

BEST Cement - Benchmarking Results (Detailed Assessment of Facility)

International Benchmarking





Instructions: The results of benchmarking your facility to a reference, best practice cement plant producing the same products under similar conditions are presented on this sheet. The results of the analysis are expressed as an intensity index. The performance (or index) of the reference facility is 100. The higher the intensity index, the larger the potential for efficiency improvement.
Note: EII = Energy Intensity Index

Summary Data	Your Facility	International Best Practice Facility	Potential for Efficiency Improvement	Potential Cost Reduction (RMB/year)
Electricity Consumption (kWh/year)	15,880,000	9,775,262	6,104,738	3,052,369
Electricity Intensity of Clinker (kWh/tonne)	82	52	30	
Comprehensive Electricity Intensity of Cement(kWh/tonne)	127	78	49	
Purchased Electricity Intensity (kWh/tonne cement)	127			
Fuel Consumption (kgce/year)	13,800,000	9,854,949	3,945,051	2,761,536
Comprehensive Fuel Intensity (kgce/tonne clinker)	138	99	39	
Final (site) Energy Consumption (kgce/year)	15,751,652	11,056,329	4,695,323	5,813,905
Final (site) Energy Intensity (kgce/tonne cement)	126	88	38	
Primary Energy Consumption (kgce/year)	19,791,572	13,543,185	6,248,387	
Primary Energy Intensity (kgce/tonne cement)	158	108	50	

Energy Use Benchmarking

(•) Final Energy Use Benchmarking ( ) Primary Energy Use Benchmarking

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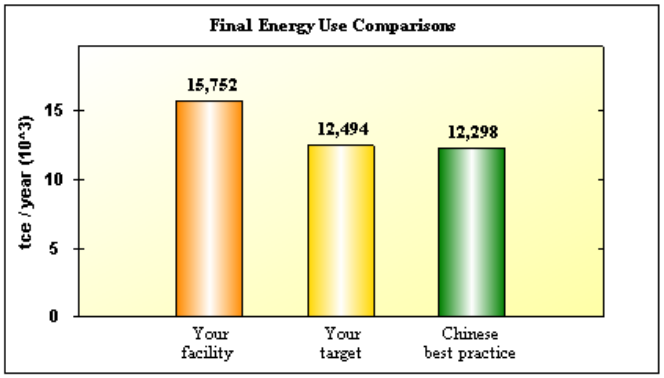
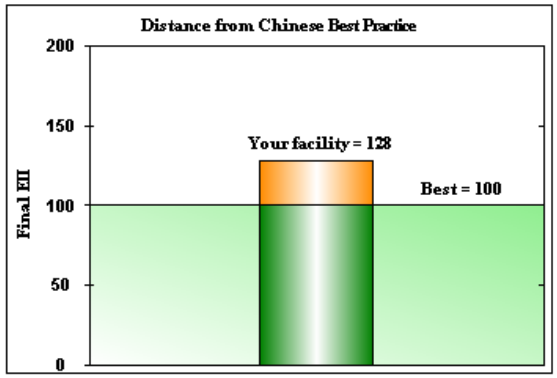
Domestic benchmarking

BEST Cement - Benchmarking Results (Detailed Assessment of Facility)

Domestic Benchmarking





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Note: EII = Energy Intensity Index

Summary Data	Your Facility	Chinese Best Practice Facility	Potential for Efficiency Improvement	Potential Cost Reduction (RMB/year)
Electricity Consumption (kWh/year)	15,880,000	11,149,609	4,730,391	2,365,196
Electricity Intensity of Clinker (kWh/tonne)	82	61	21	
Comprehensive Electricity Intensity of Cement(kWh/tonne)	127	89	38	
Purchased Electricity Intensity (kWh/tonne cement)	127			
Fuel Consumption (kgce/year)	13,800,000	10,927,986	2,872,014	2,010,410
Comprehensive Fuel Intensity (kgce/tonne clinker)	138	109	29	
Final (site) Energy Consumption (kgce/year)	15,751,652	12,298,273	3,453,379	4,375,605
Final (site) Energy Intensity (kgce/tonne cement)	126	98	28	
Primary Energy Consumption (kgce/year)	19,791,572	15,134,767	4,656,804	
Primary Energy Intensity (kgce/tonne cement)	158	121	37	

Energy Use Benchmarking
(•) Final Energy Use Benchmarking ( ) Primary Energy Use Benchmarking

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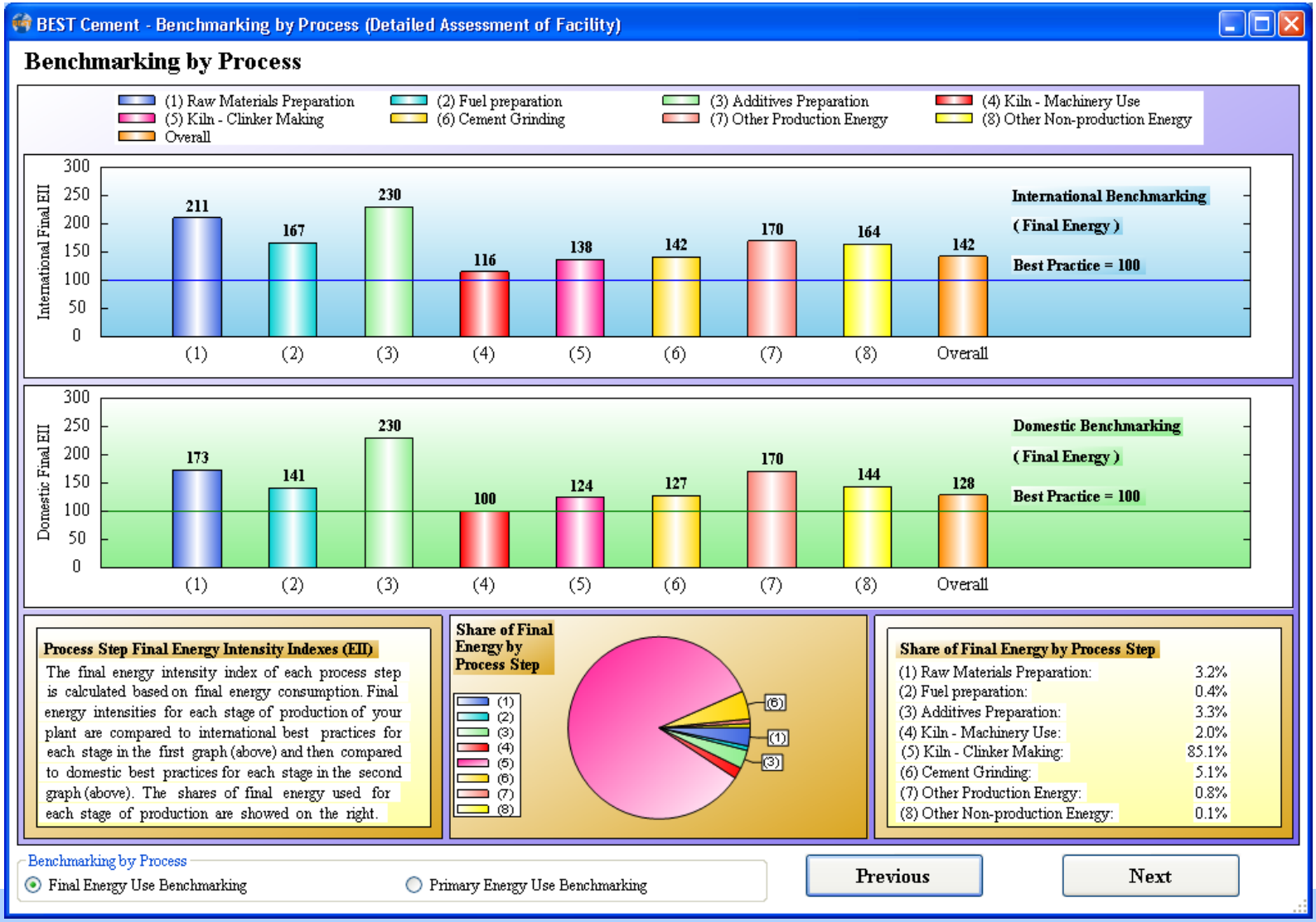
Benchmarking by process



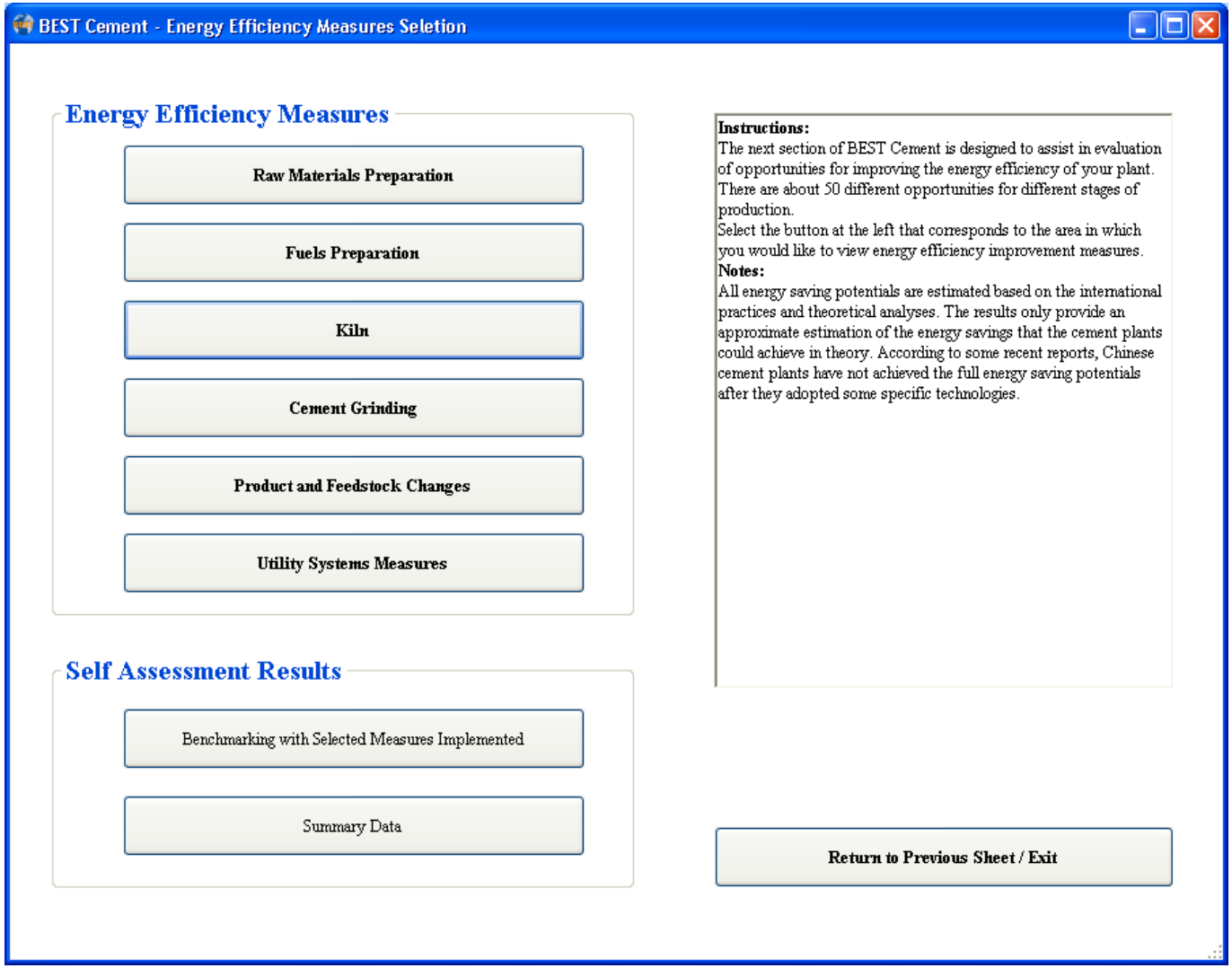
Energy efficiency measures

• After benchmarking the cement plant's performance, BEST Cement can be used to evaluate the impact of selected energy efficiency measures.

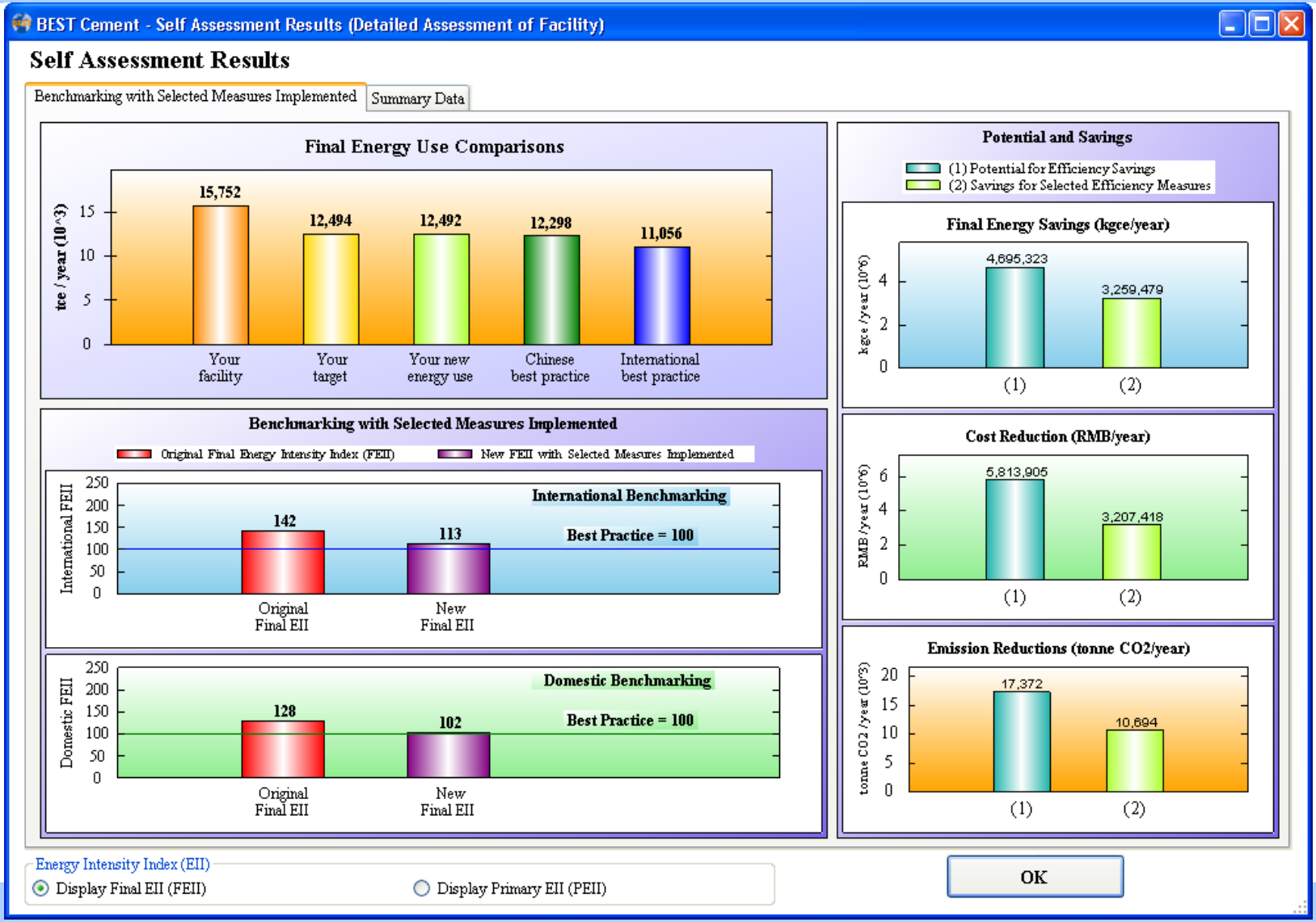
• BEST Cement provides information on approximately 50 energy-efficiency measures that can be used in cement plants, including their cost, energy savings, simple payback time, carbon dioxide emissions reduction, etc.

• The user selects the degree or share of implementation for each of the measures, and the BEST Cement then calculates the overall cost to implement the chosen measures along with the related energy and emissions savings, cost savings, payback period and a re-calculated benchmark.

Energy efficiency measures selection



Self assessment with selected measures implemented



If you have any technical difficulties, please contact one of the following:

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