IEE Benchmarking System in the "Cement" sector in "Islamic Republic of Iran"

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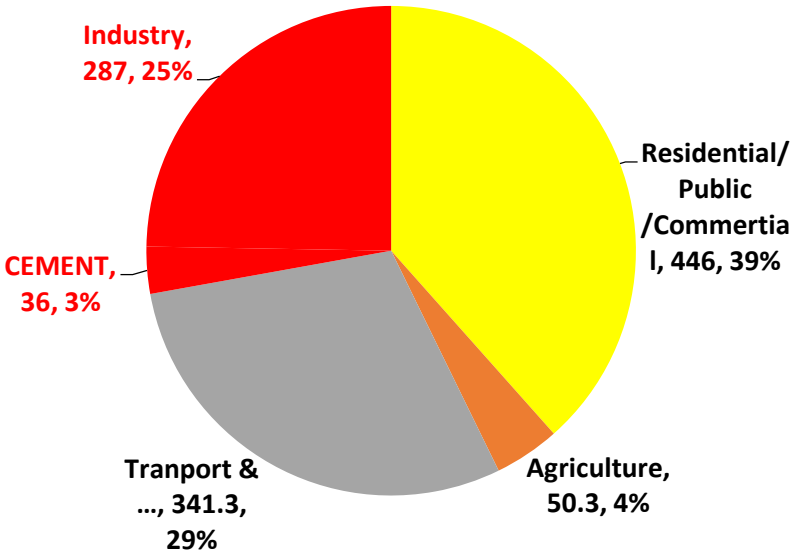
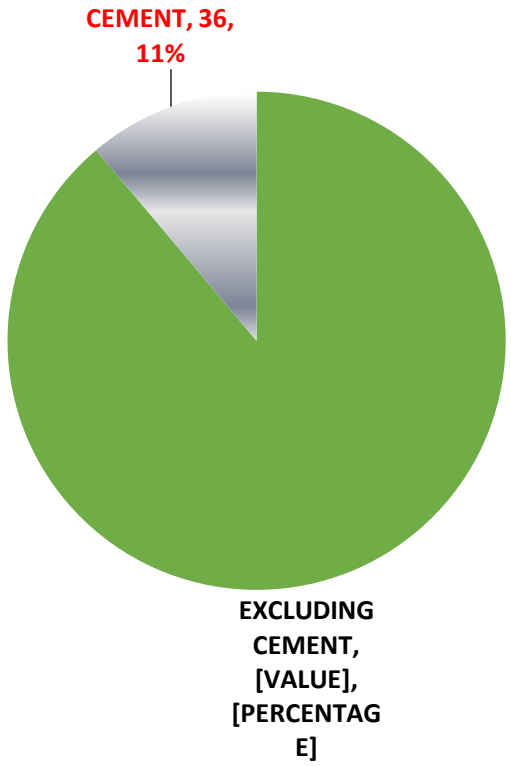
Introduction – Final Energy Consumption (2014)

Total: **1161** M BOE

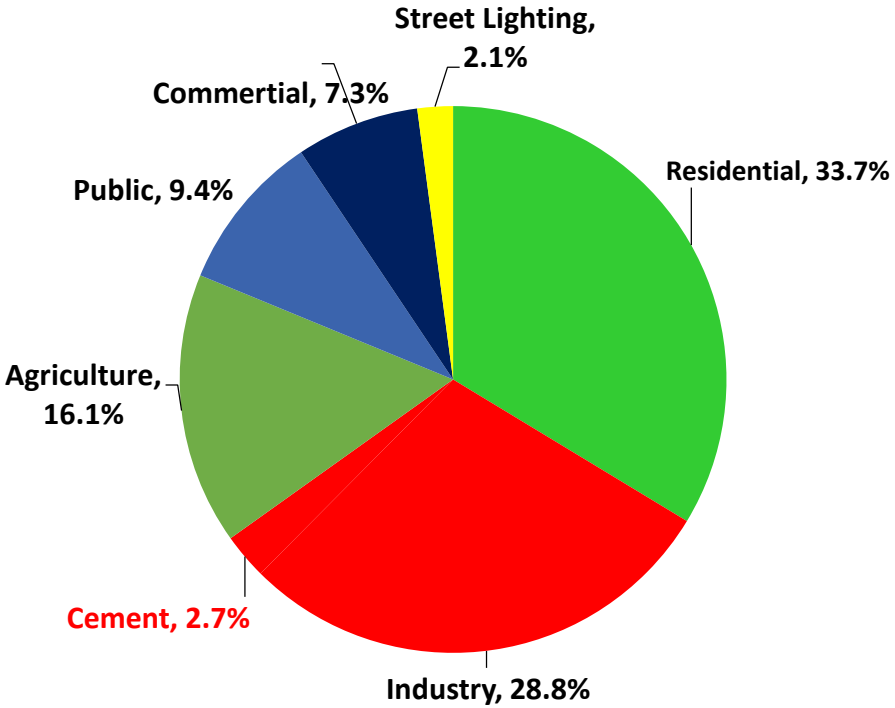


Industry

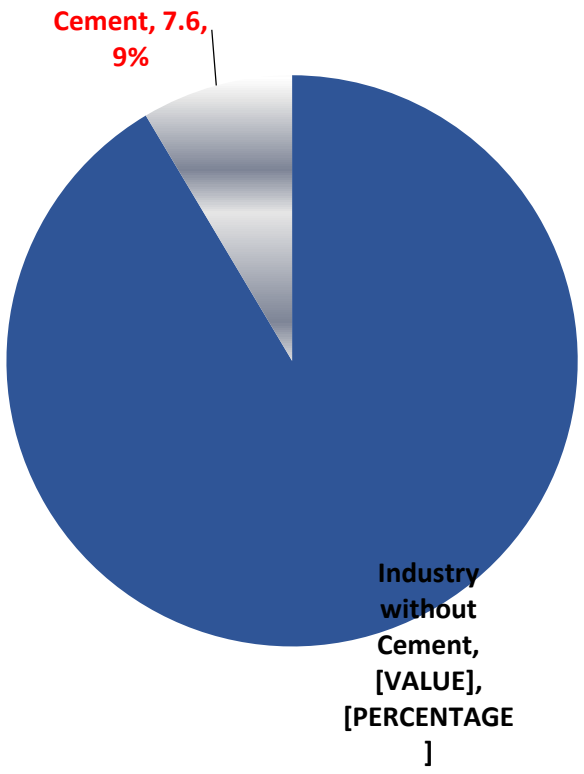


Introduction – Electricity Consumption (2014)

Total: 282 B kWh



Industry

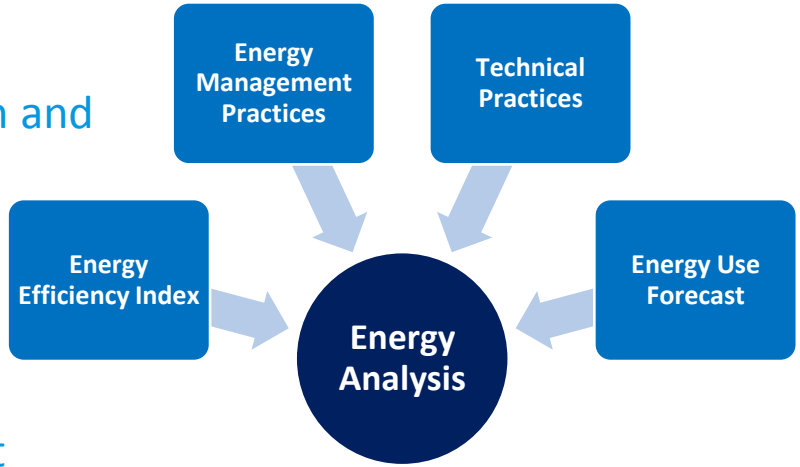


Purpose of the benchmarking system

- Understand the current energy consumption of the sector and create awareness for policy makers;
- Develop a norm for comparison of energy use of the cement industries within Iran and understand where they stand from international practices;
- Understanding of the energy saving potential and assess the current barriers of implementing Energy Efficiency;
- Understand current adoption of Energy Efficient Measures in the Sector;
- Develop Projection Scenarios to facilitate decision makers to understand the affects of implementing Energy Efficient measures;

Methodology: Data Collection Process

- Two Phases of data collection Process
- Phase 1 data collection:
  - General information of cement plant
  - Process data data of cement plant (production and energy consumption by source)
  - Historical data of 3 year (2013, 2014, 2015)
- Phase 2 data collection:
  - Detailed data collection to understand current management practices and barriers to implement energy efficiency
  - Detailed data collection of current technical practices in the plant (29 shortlisted technology measures)



Methodology: Data Sample

- Present Cement production scenario:
  - **71 Cement Plants** with a total of **95 Production Lines**
  - Total production of 58.7 Mil. tonne (2015)
  - Portland cement represents 98.3% of total production **(86 production lines)**
- Benchmarking Sample Size:
  - **16 Cement Plants** with a total of **23 Production Lines**
  - Total production of 15.41 Mil. tonne (2015)
  - Sample size equivalent to 27% of the national production
- Eliminating Anomalies:
  - Production lines with production rates lower than 60% of the nominal capacity for each process was considered as abnormal data and eliminated from analysis (9 Production lines with abnormal data were eliminated)

Methodology: Benchmarking Indicators

- **Energy Intensity (EI)**- defined as energy consumption per unit of product;
- Lowest value of EI at each process is considered as **"domestic best practise"** technology for that process;
- **"Domestic best practice plant"** is developed through a combination of "domestic best practice" EI values for each process;
- **Energy Efficiency Index (EII)**- used to evaluate the energy efficiency potential at the production line by comparing the actual line's energy intensity to the intensity of the reference best practice line;
- **Process Level EI units -**

Raw Material Processing	Clinker Making	Finish Grinding
kWh/t raw materials	kCal/t clinker; kWh/t clinker	kWh/t cement

Total Energy Intensity
kCal/t cement

Methodology: Benchmarking Indicators (Cont.)

- Total Energy Intensity:

$$EI_{xtot} = \underbrace{EI_c}_{\text{Finish Grinding (Electricity)}} + \left(\frac{P_{cl}}{P_c} * \underbrace{EI_{cl}}_{\text{Clinker Making (Electricity + Heat)}}\right) + \left(\frac{P_{r.m.}}{P_{cl}} * \frac{P_{cl}}{P_c} * \underbrace{EI_{r.m.}}_{\text{Raw Material Processing (Electricity)}}\right)$$

- Process related Energy Efficiency Index:

$$EEI_x = \frac{EI_x}{EI_{\boldsymbol{BAT}}} * 100$$

- Overall Energy Efficiency Index:

$$EEI_o = \frac{EI_{x\,tot}}{EI_{BATtot}} * 100$$

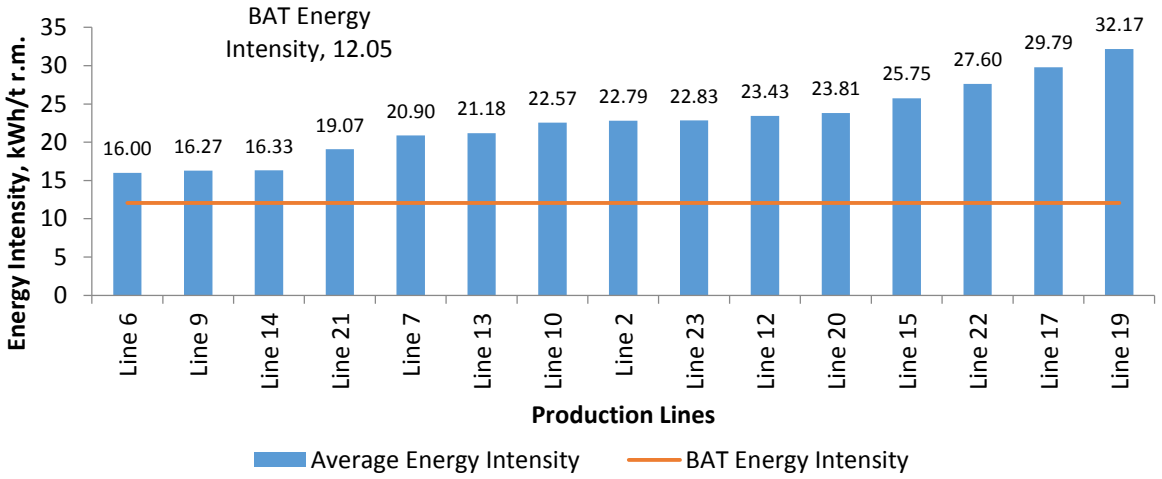
- Technology Adoption Rate of Technology X:

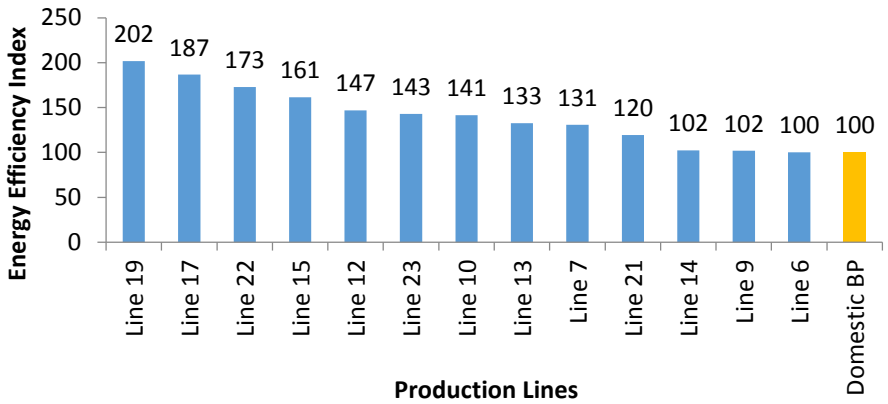
$$TAR_x = \frac{\Sigma P_{i,x}}{\Sigma P_i} * 100\%$$

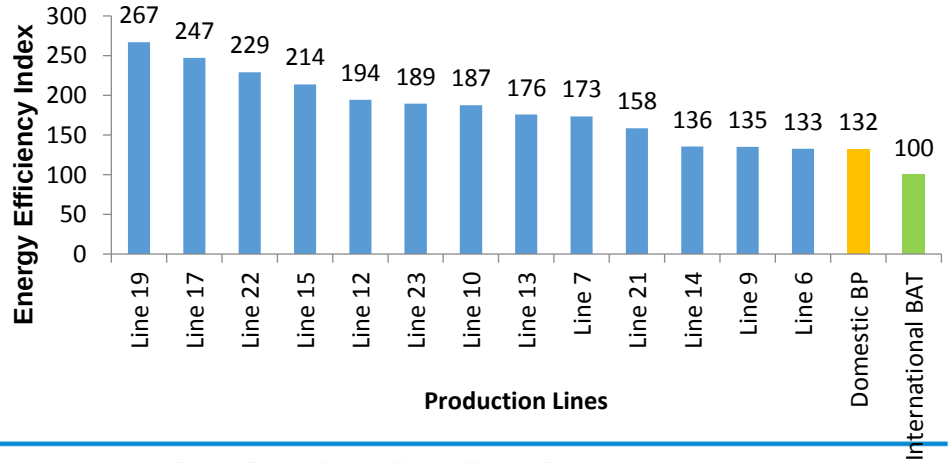
Benchmarking Results: EI & EEI

Raw Material Processing

- Energy Intensity
- Energy Efficiency Index





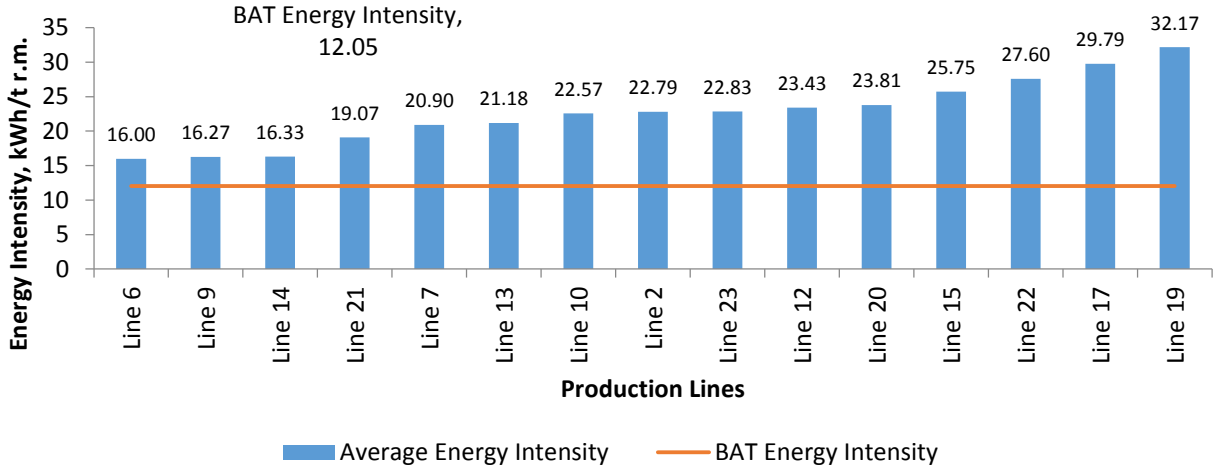


Benchmarking Results: EI & EEI

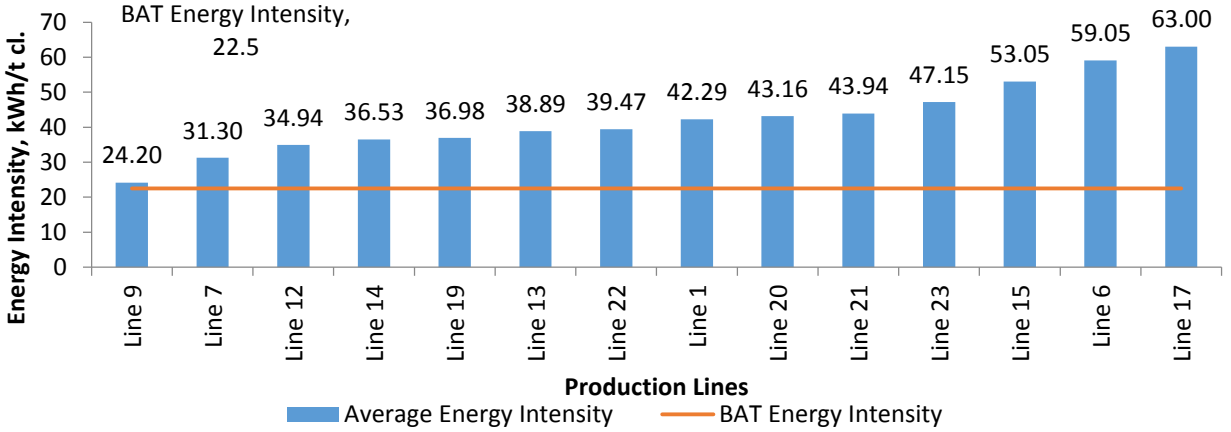
Clinker Making

Energy Intensity

- Electrical



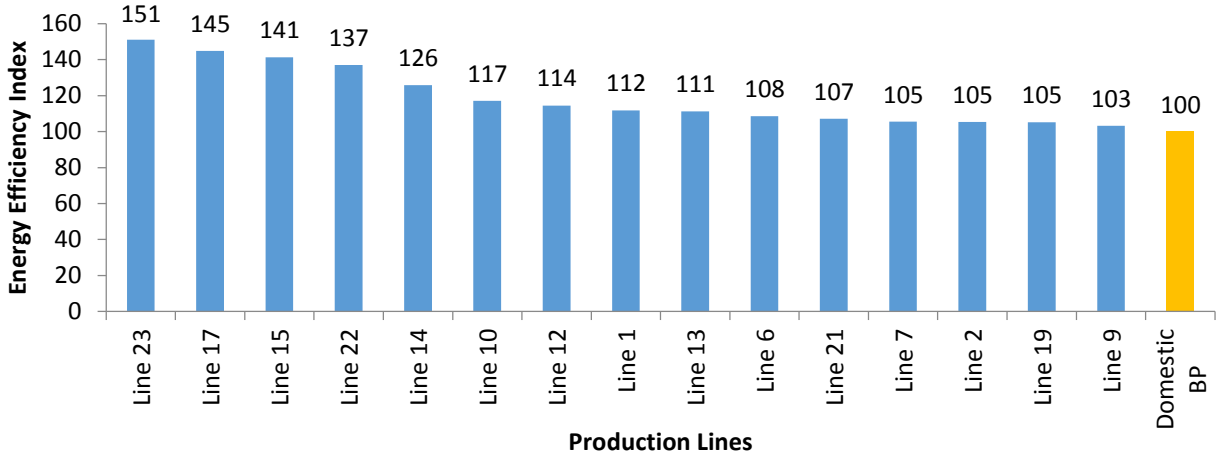
- Thermal

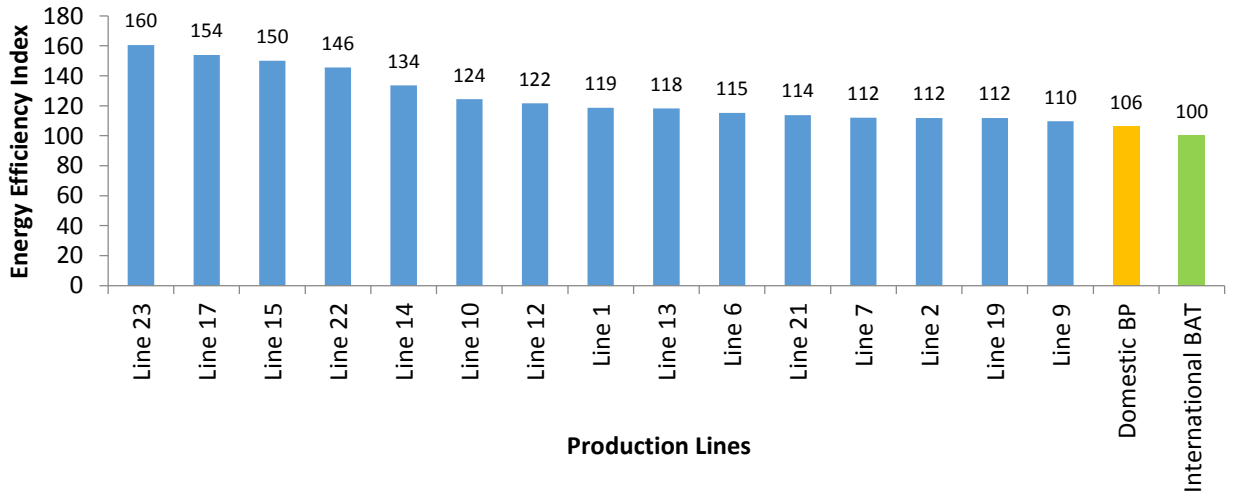


Benchmarking Results: EI & EEI

Clinker Making:

Energy Efficiency Index

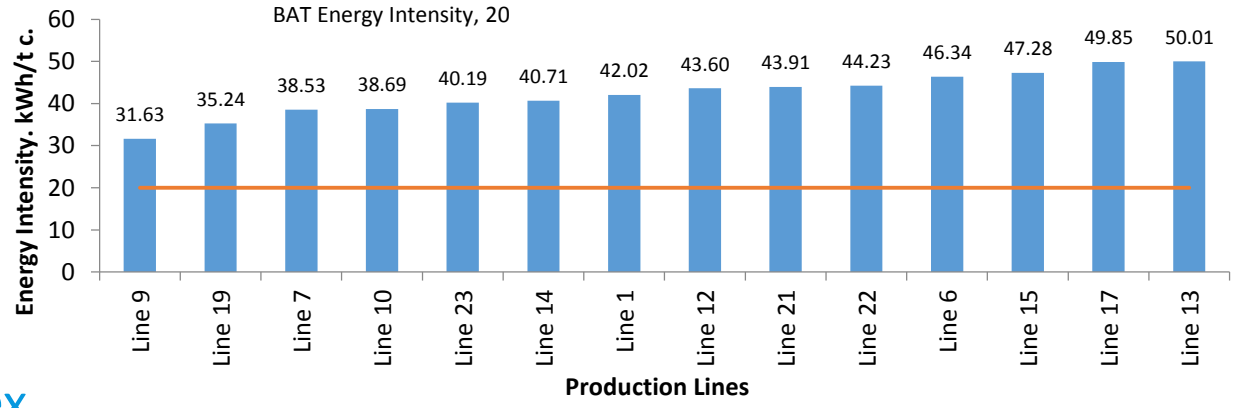




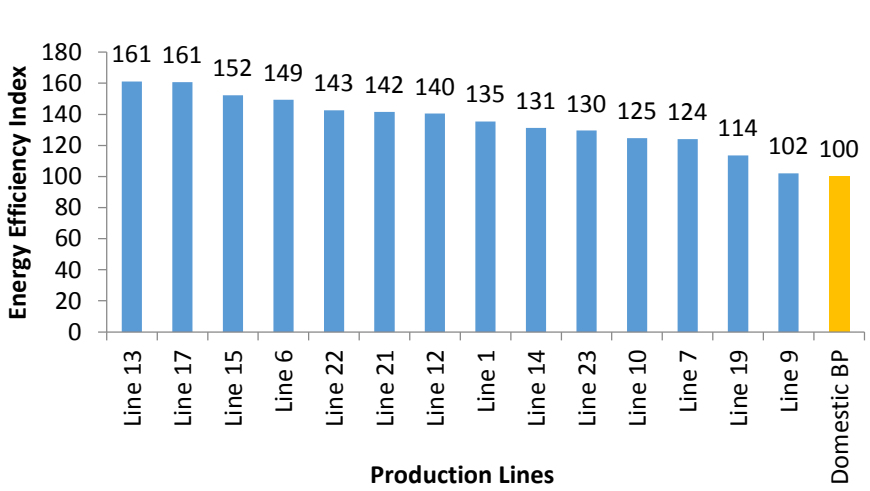
Benchmarking Results: EI & EEI

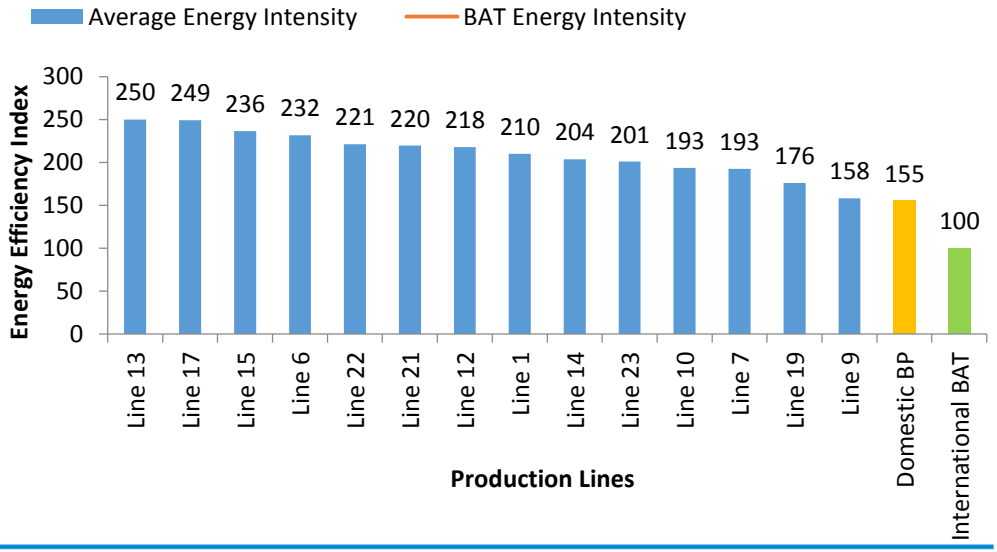
Cement Grinding

- Energy Intensity



- Energy Efficiency Index

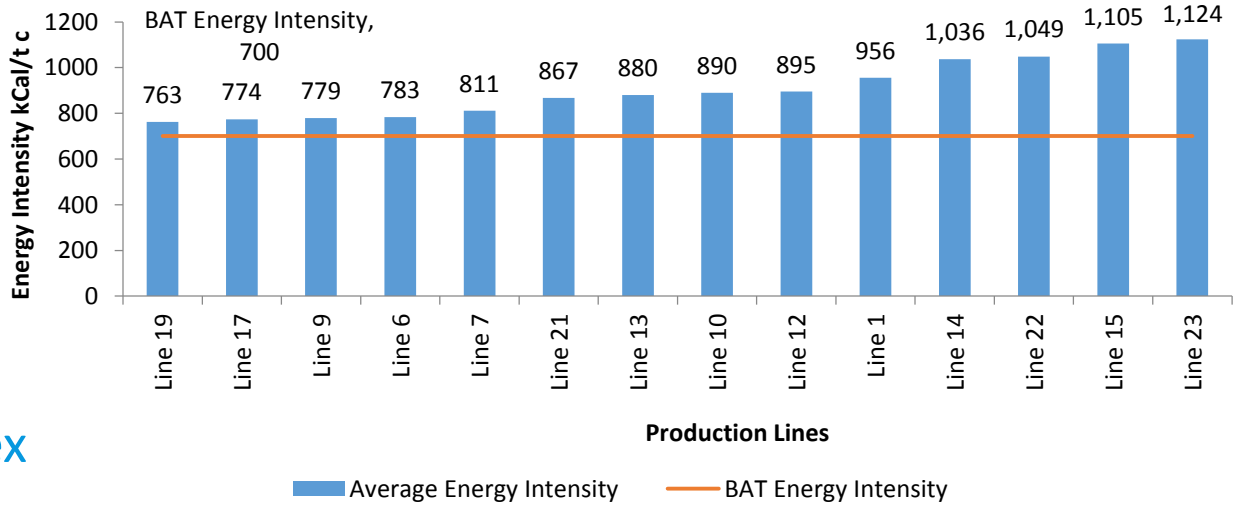




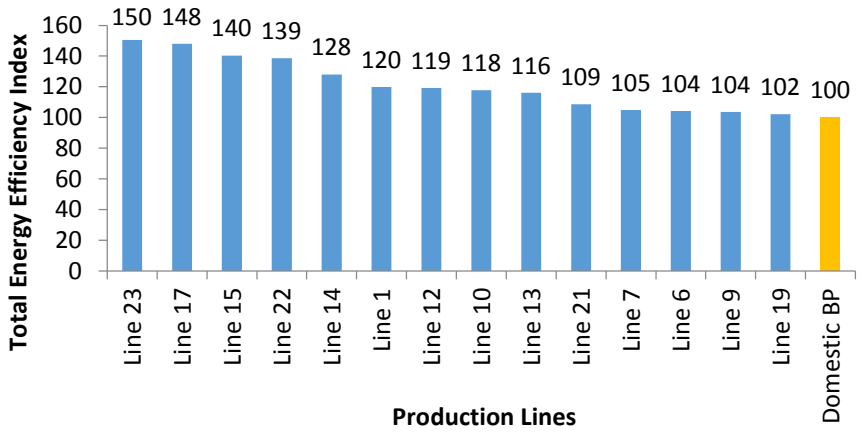
Benchmarking Results: EI & EEI

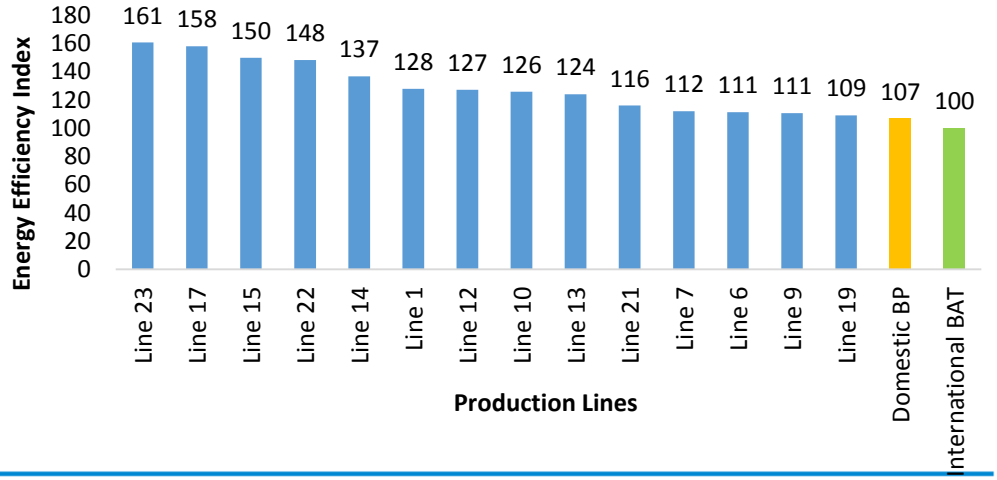
Total

- Energy Intensity



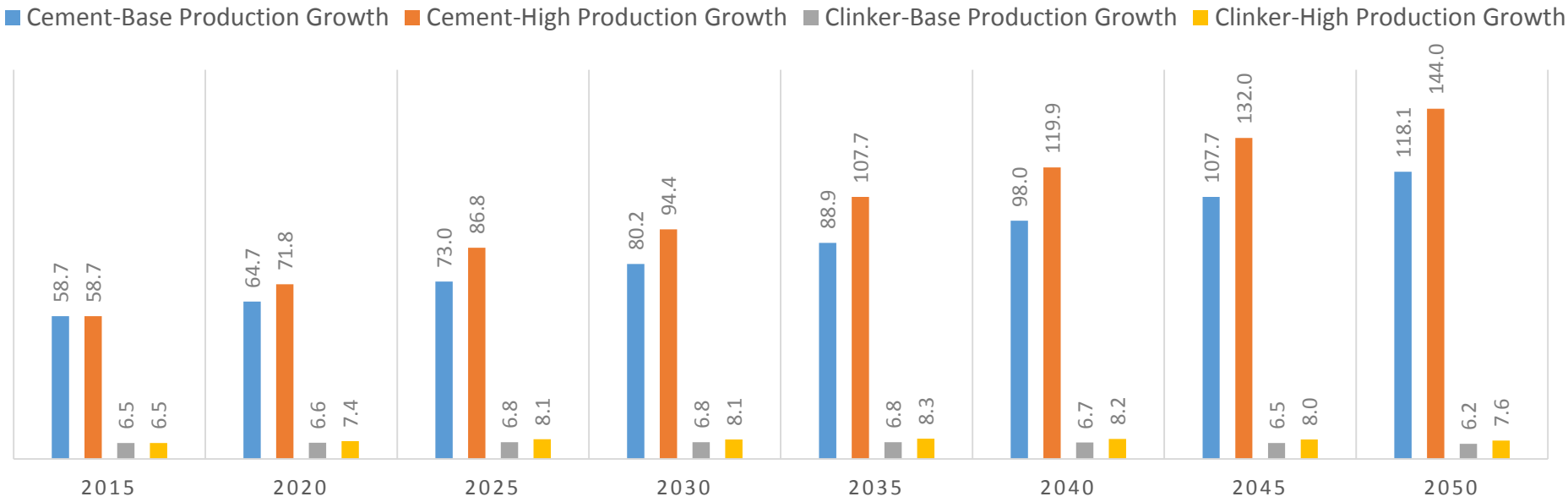
- Energy Efficiency Index





One Major Outcome of Benchmark Findings:
Energy Projection Scenario (2015-2050)- Methodology

- Understanding Cement Production (Projected Value in MTonne)
- Understanding Excess Clinker Production (Projected Value in MTonne)
  - Assumption that Clinker Export will reduce from 10% (2015) to 5% (2050)



Energy Projection Scenario (2015-2050)

Understanding of Energy Intensity Variation for Frozen Energy Efficiency Scenario Case

- Assumed that Clinker to Cement Ration will reduce from 0.91 in 2015 to 0.75 in 2050
- Assumed that the Raw Material to Clinker Ratio will remain constant at 1.6

Year	Clinker to Cement Ratio	Raw Material to Clinker Ratio	Average Electricity Intensity (kWh/tc)	Average Fuel Intensity (GJ/tc)	Average Final Energy Intensity (GJ/tc)
2015	0.910	1.6	101	3.16	3.53
2020	0.887	1.6	99	3.08	3.44
2025	0.864	1.6	98	3.00	3.36
2030	0.841	1.6	96	2.93	3.27
2035	0.818	1.6	95	2.85	3.19
2040	0.796	1.6	93	2.77	3.10
2045	0.773	1.6	91	2.69	3.02
2050	0.750	1.6	90	2.61	2.93

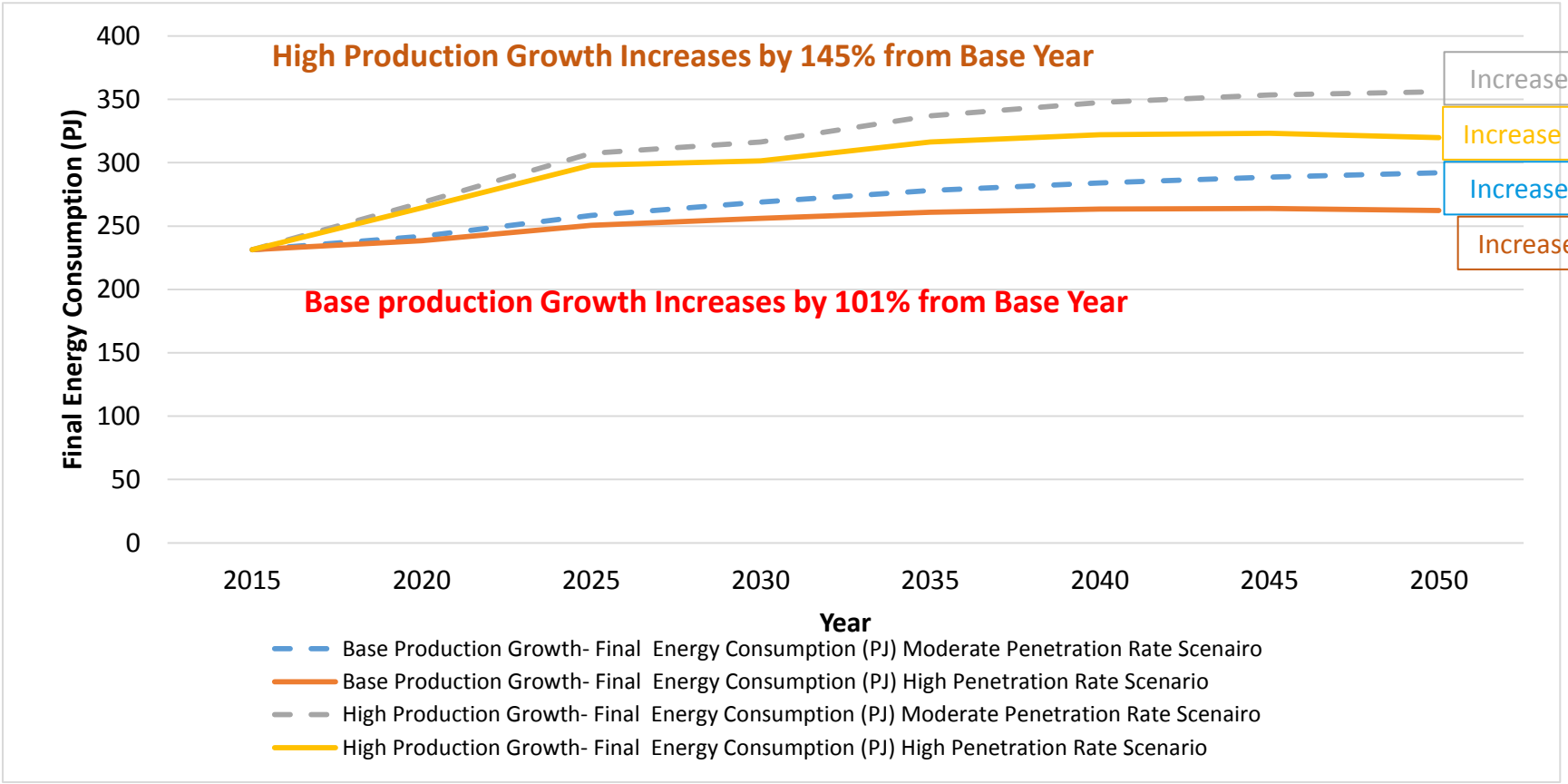
Energy Projection Scenario (2015-2050)-Methodology

- **Technology Adoption Potential** – Used for 29 Technologies

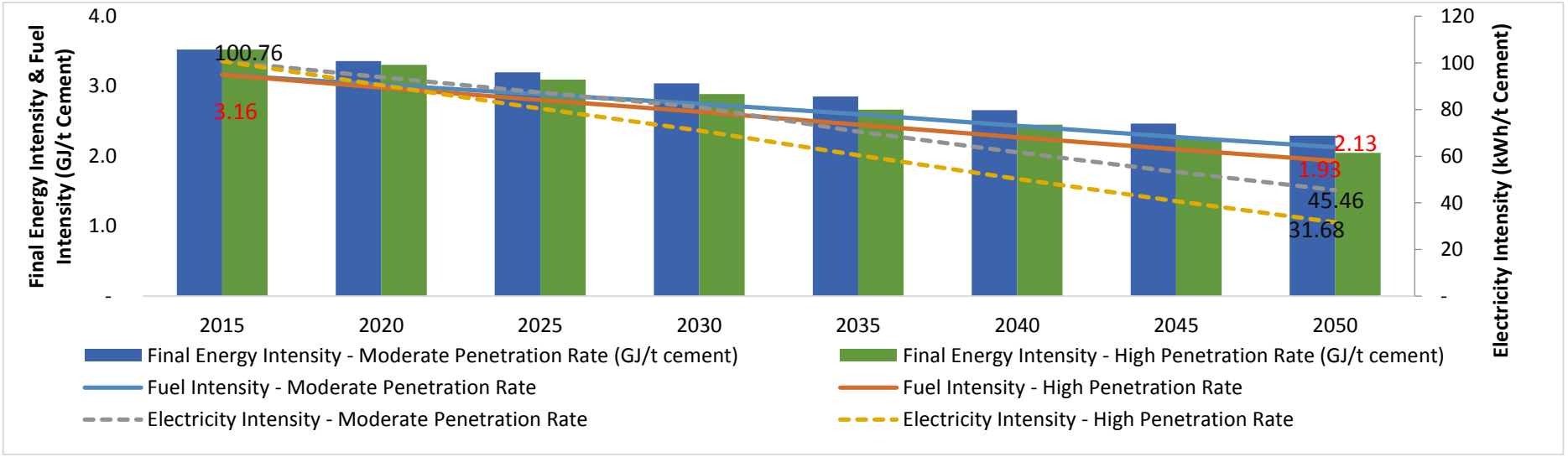
Technology No.	Technology Adoption Rate	Technology Adoption Potential
Raw Materials Preparation		
High-efficiency classifiers/separators	75%	25%
Raw materials grinding	69%	31%
Clinker Making		
Low temperature heat recovery for power generation	0%	100%
Bucket elevators for kiln feed	40%	60%
Finishing Grinding		
Energy management and process control	58%	42%
Replacing a ball mill with Vertical roller mill	34%	33%
General measures		
Use of alternative fuels	6%	94%

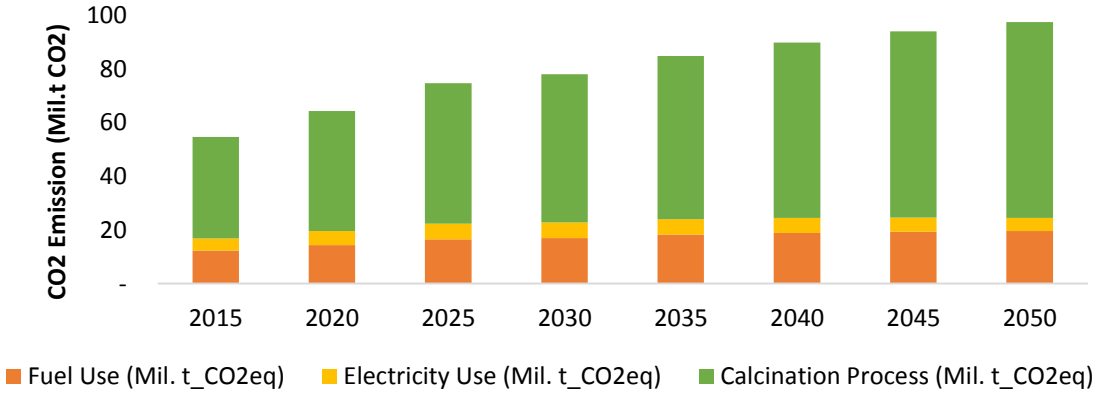
- **Market Penetration of Energy Efficient Technologies:**
  - **Moderate Penetration Rate Scenario** : Increase 1.5% and 2.5% per year during 2015 - 2030 and 2030 - 2050 respectively
  - **High Penetration Rate Scenario**: Increase 2.5% and 3% per year during 2015 - 2030 and 2030 - 2050 respectively

Energy Projection Scenario (2015-2050)-Result
Total Energy Consumption Projection



Energy Projection Scenario (2015-2050)-Result (EI and Emission)





Moderate Penetration Rate of Technology

CO2 Emission 2015 = 0.929 tCO2/t C
CO2 Emission 2050 = 0.676 tCO2/t C

High Penetration Rate of Technology

CO2 Emission 2015 = 0.929 tCO2/t C
CO2 Emission 2050 = 0.654 tCO2/t C

Benchmarking and Projection Results:

Summary of Benchmarking Analysis Outcome – Energy Saving Potential

Process	Energy Efficiency Index of Domestic BP comparing to International BAT	Potential for Energy Savings among studied plants
Raw Material Grinding	132	33 – 167%
Clinker Making	106	10 – 60%
Finish Grinding	155	58 – 150%
Overall / Total	107	9 – 61%

Summary of Projection Analysis Outcome – Energy Saving Potential

	Moderate Efficiency Penetration Rate Scenario	High Efficiency Penetration Rate Scenario
Energy Saving Potential in 2050:	20.9%	29.0%

Strength and weaknesses

Strengths

- Analysis is broken down into each process and source of energy - this can allow for prioritization project implementation for Plants;
- Allows to understand the status of Energy Efficient technologies in the industries – this allows policy makers to understand which technologies need to be further promoted;
- Information collected on actual issues in implementing Energy Efficiency – allows to prioritize issues that need to be addressed by policy makers;

Weaknesses

- Final size of sample production lines were low for a more conclusive benchmarking study;
- Data on technology related energy savings were based international practices and not on actual data from Iran;
- Future cost of implementing Energy Efficiency could enhance the decision making process for policy makers;

Future Plans and Recommendations

- Policy Support: Energy standards, Environmental regulation and Carbon emission trading; Energy services contracts;
- Training and awareness raising on Energy efficiency technologies and techniques;
- Promote certified and sustainable training structure to Energy managers on EnMS;
- Provide Indirect Supports like low custom duties and facilitation of importing high energy efficient technologies and equipment;
- Guaranteed Purchasing Power from WHR and Losses;
- Subsidies to energy efficient technologies;
- Feed-in-tariff plans: Energy purchasing from energy exchange market;
- Load Management: Power courier contracts, Time of Use (TOU) etc.;
- Promote special cement (lower Clinker to Cement ratio) products

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