



# GE Global Power Plant Efficiency Analysis



GE used a propriety set of data to analyze each coal and gas-fired plant in the world to uncover opportunities to improve plants' heat rate and lower carbon emissions.

## KEY FINDINGS

The technology to lower global carbon emissions and make coal and gas more efficient is available now – countries and companies alike should be taking advantage of this to meet our climate goals.

CO2 emissions from the world's fleet of coal and gas plants can be reduced by 1,128 million metric tonnes per year. That's a 10% reduction in global power plant emissions, the equivalent of removing 95% of the cars off U.S. roads – when existing hardware and software solutions are fully applied.

The biggest opportunity is to upgrade coal plants in India and China.

## POTENTIAL FOR COAL UPGRADES

The average global efficiency of coal plants can be improved from 34% to 38%.

- 2.5% through hardware improvements such as turbines and boiler upgrades.
- 1.5% more efficient through software solutions and data analytics.

Annual CO2 emissions from coal plants can be reduced by 924 mt or 11% (8,749 mt to 7,825 mt). That's more than the annual CO2 emissions of:

- Germany (729 mt)\*
- The UK and France combined (786 mt)\*
- Texas and Indiana combined (840 mt)\*\*
- 250 million US cars

64% of the CO2 reduction come from just three countries.

- China = 296 mt CO2 reduction
- US = 151 mt CO2 reduction
- India = 143 mt CO2 reduction
- Other opportunities for improvement exist in Russia, Germany and South Africa.

## COAL: TOP 20 COUNTRIES BY CO2 REDUCTION POTENTIAL

Country	2015 Coal Generation (MWh)	Average Power Plant Efficiency (%)	Technical Potential Average Power Plant Efficiency with Upgrades (%)	Potential CO2 Reductions (mt)	% Change in CO2 Emissions
World	8,920,141	34%	38%	924	11%
China	3,594,958	35%	39%	296	9%
United States	1,356,121	37%	42%	151	12%
India	1,009,741	27%	31%	143	12%
Russia	172,394	25%	30%	37	16%
Germany	315,741	36%	41%	31	11%
South Africa	244,373	34%	39%	28	12%
Japan	276,887	37%	41%	24	9%
Korea	236,017	35%	38%	21	9%
Australia	170,693	35%	39%	19	12%
Poland	134,906	34%	39%	16	12%
Ukraine	82,750	30%	36%	14	16%
United Kingdom	116,641	38%	44%	13	13%
Indonesia	123,140	31%	34%	13	10%
Kazakhstan	72,715	30%	35%	11	14%
Taiwan	121,474	38%	42%	10	10%
Czech Republic	45,316	28%	33%	8	15%
Turkey	80,477	34%	38%	8	10%
Canada	64,495	38%	43%	6	11%
Spain	55,074	36%	41%	6	12%
Vietnam	63,760	35%	38%	5	9%

Source: GE Estimates

\*<http://data.worldbank.org/indicator/EN.ATM.CO2E.PC>

\*\*<http://www.eia.gov/environment/emissions/state/>

## POTENTIAL FOR GAS UPGRADES

The average global efficiency of gas plants can be improved from 39.4% to 42.7%.

- 1.8% through hardware improvements such as turbines and boiler upgrades.
- 1.5% more efficient through software solutions and data analytics.

Annual CO<sub>2</sub> emissions from gas plants can be reduced by 203 mt or 8% (2,625 mt to 2,422 mt).

The greatest potential comes from:

- Russia = 45 mt CO<sub>2</sub> reduction (12% efficiency gain)
- US = 34 mt CO<sub>2</sub> reduction (6% efficiency gain)
- Japan = 12 mt CO<sub>2</sub> reduction (7% efficiency gain)
- Other opportunities for improvement exist in Saudi Arabia, China and United Arab Emirates

## GAS: TOP 20 COUNTRIES BY CO<sub>2</sub> REDUCTION POTENTIAL

Country	2015 Gas Generation	Average Power Plant Efficiency (%)	Technical Potential Average Power Plant Efficiency with Upgrades (%)	Potential CO <sub>2</sub> Reductions (mt)	% Change in CO <sub>2</sub> Emissions
World	5,713,194	39%	43%	203	8%
Russian Federation	564,068	26%	30%	45	12%
United States	1,316,652	45%	48%	34	6%
Japan	427,836	45%	48%	12	7%
Saudi Arabia	160,229	32%	36%	11	12%
Iran	184,498	43%	46%	6	7%
United Arab Emirates	107,746	34%	37%	4	7%
China	134,041	39%	42%	4	7%
Korea	163,691	44%	46%	4	5%
Egypt	152,635	45%	48%	4	6%
India	153,579	45%	48%	4	6%
Uzbekistan	40,581	28%	33%	4	13%
Mexico	164,055	45%	47%	3	5%
Thailand	142,853	45%	48%	3	5%
Turkey	133,861	45%	48%	3	6%
Algeria	67,189	38%	42%	3	9%
Belarus	33,648	28%	32%	3	13%
Italy	129,633	45%	47%	3	5%
Canada	72,914	41%	44%	2	8%
Australia	54,811	39%	43%	2	10%
Turkmenistan	22,606	25%	29%	2	14%

Source: GE Estimates

\*<http://data.worldbank.org/indicator/EN.ATM.CO2E.PC>

\*\*<http://www.eia.gov/environment/emissions/state/>

## CONTEXT

According to the International Energy Agency (IEA) World Energy Outlook 2016, in 2014, 41% of global electricity generation came from coal-fired power plants and 22% came from gas-fired power plant. Both coal- and gas-fired electricity generation are expected to increase over the next decade in both IEA's Current and New Policies scenarios.

Because coal is more carbon intensive than other generation fuels, in 2014, it accounted for 73% of electric sector carbon dioxide emissions. Gas accounted for 20% of global power plant carbon dioxide emissions.

In a carbon-constrained world, technologies such as natural gas, highly-efficient greenfield coal plants, renewable energy, hydropower and nuclear power are helping to reduce global electric sector CO2 emissions. However, another, often overlooked strategy is to reduce CO2 emissions by increasing the efficiency of the existing fleet of coal-fired power plants.

## IMPLICATIONS

Countries and companies should consider how coal and gas plant upgrades can contribute to their wider energy and climate change strategies.

Areas for consideration include R&D funding, permitting, and financing.

## METHODOLOGY

GE examined every power plant across the globe and estimated the potential CO2 impact if these plants were fully upgraded through steam turbine, boiler and/or advanced digital control upgrades. GE estimates were based on internal analysis and source data from the International

Energy Agency. GE examined the suite of upgrades that are technically achievable today. The study did not include an economic analysis.

## ABOUT THIS STUDY

Ecomagination, GE's business strategy to address the world's toughest environmental challenges, is continuously examining technology and business solutions that span the global resource spectrum. Given current trends, electricity produced from coal and gas will continue to play an important role in the global energy mix for the foreseeable future. GE Ecomagination conducted the analysis in this study to learn more about the opportunities to improve efficiency and reduce carbon output from coal plants.

Our research was spurred by GE's recent acquisition of Alstom's energy businesses, which includes a portfolio of coal-related energy products. The findings are dramatic and something the international energy industry and policy makers should consider as we all work to reduce the carbon intensity of the global energy system.

To learn more and download the full data set please visit:

[www.ecomagination.com](http://www.ecomagination.com)