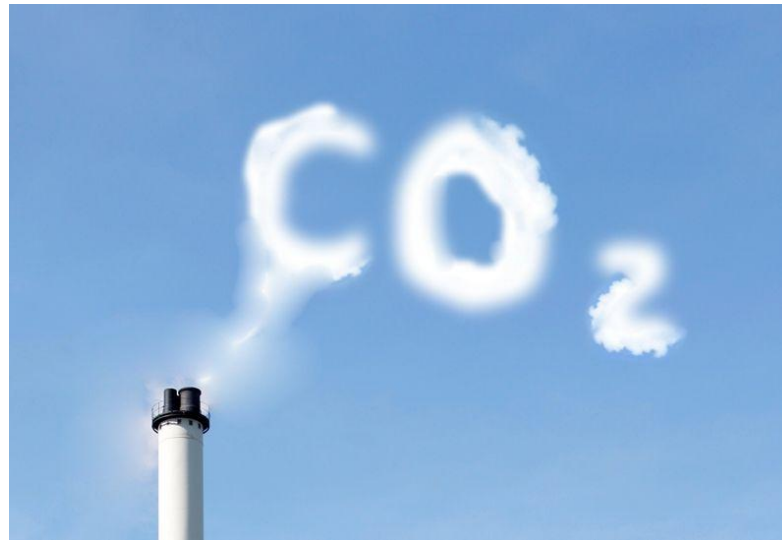


# CARBON EMISSIONS FROM POWER SECTOR IN 2021-22 and 2026-27



Central Electricity Authority  
New Delhi  
30.06.2018

# Per Capita CO2 Emissions

(all sectors) (t CO2/capita)

- World – 4.7
- **India - 1.6**
- China – 6.3
- Germany – 9.2
- France – 5.1
- USA - 16.4

	Total Fossil Fuel CO2 emissions kilo tonne 2016
<b>World</b>	<b>35,753,306</b>
China	10,432,751
United States	5,011,687
<b>India</b>	<b>2,533,638</b>



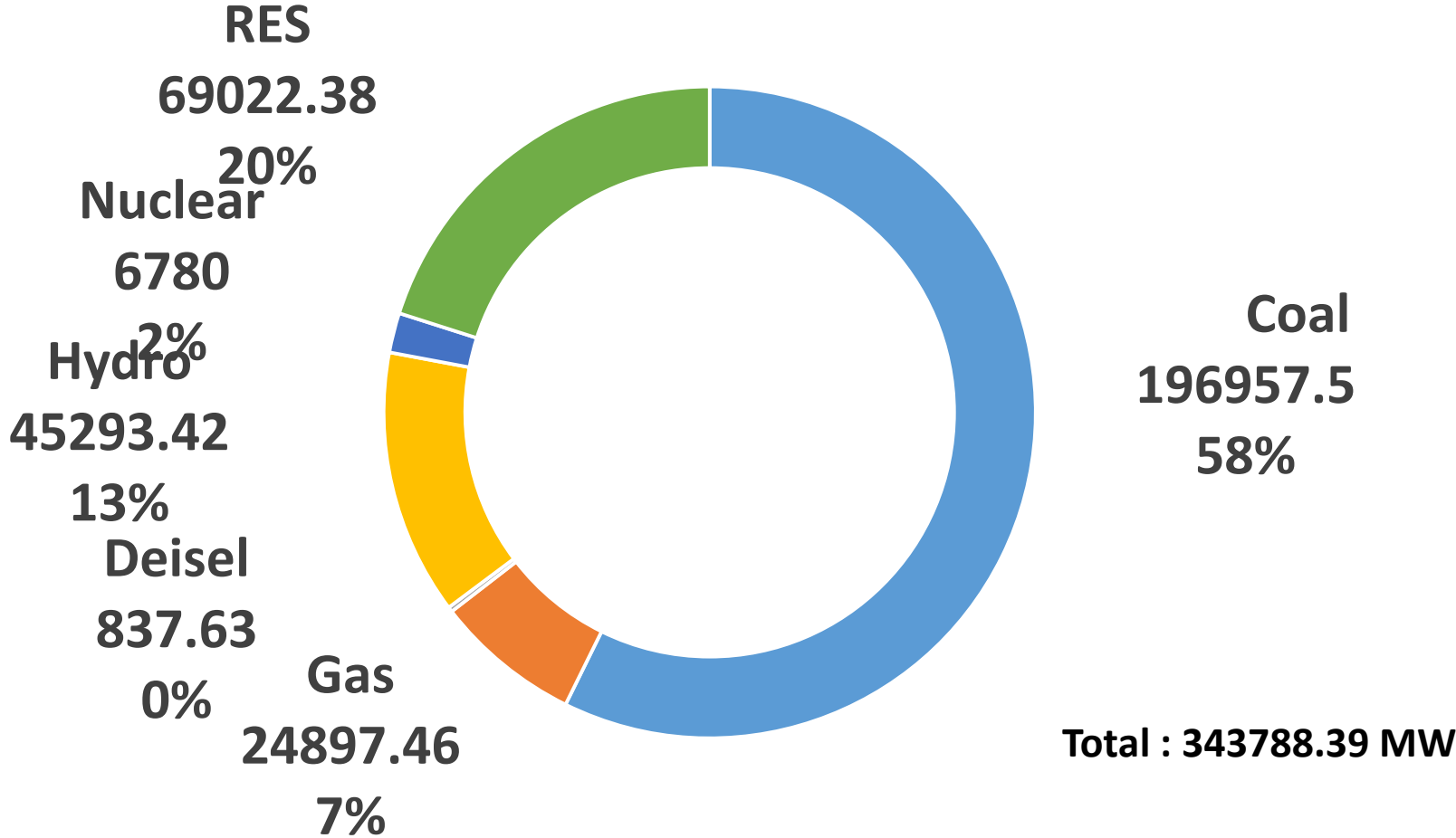
3rd Largest  
Contributor

(Source: UN Human Development Report 2016)

# Main Sources of GHG Emissions

- Energy Sector - Power
  - Transport Sector
  - Agriculture Sector
  - Industrial Sector
- Power sector is estimated to contribute around 50% of total CO2 Emissions

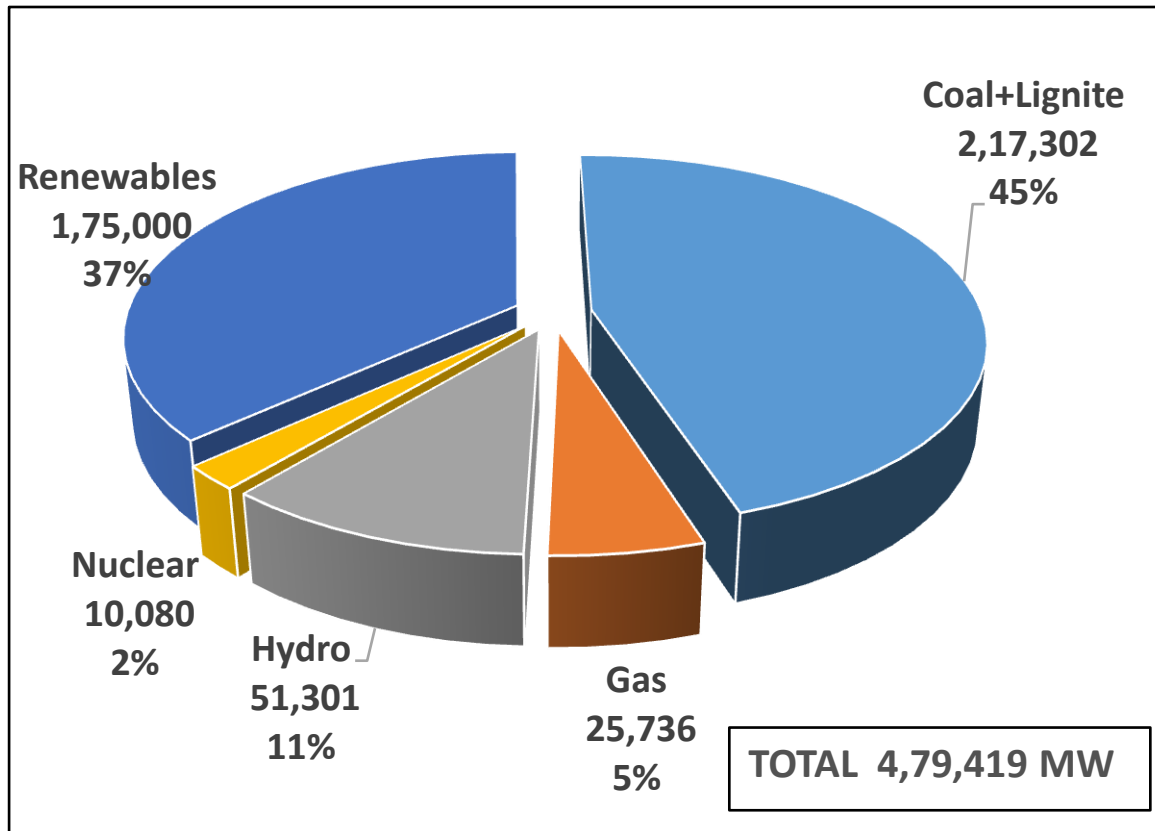
# Installed Capacity as on 30.4.2018



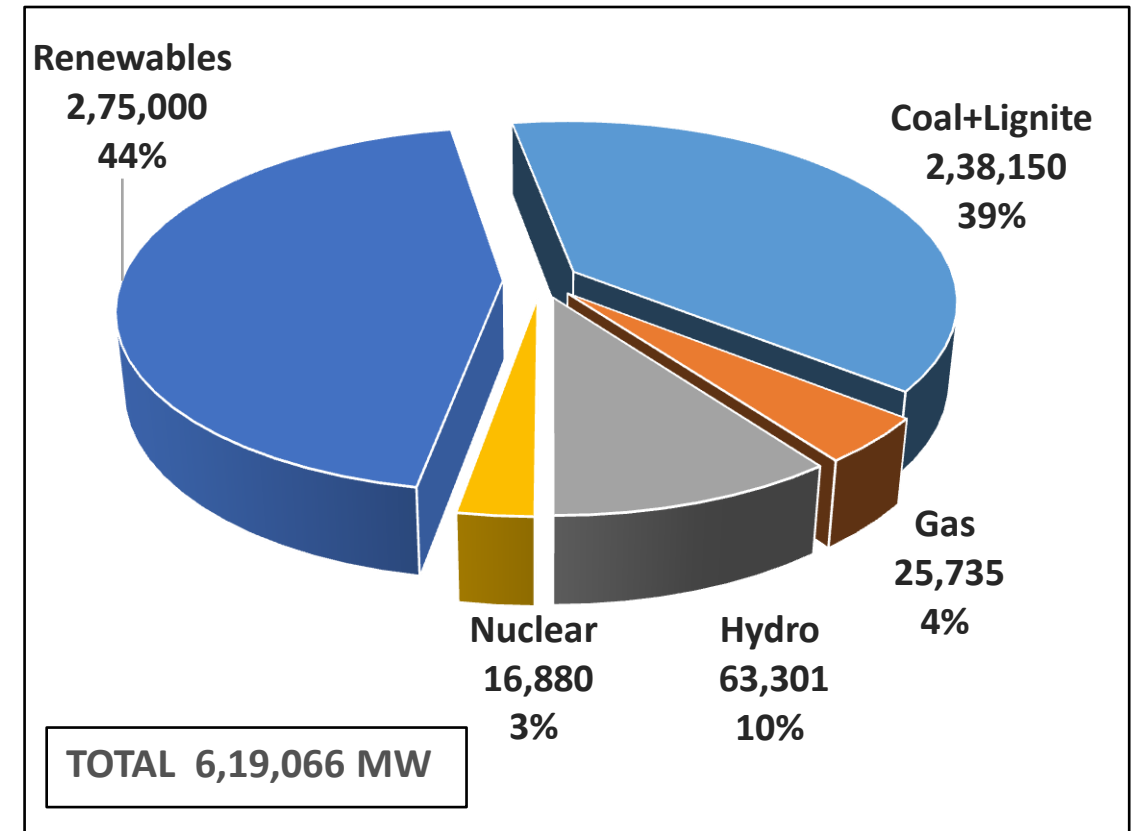
*ALL FIGURES IN MW*

# Projected Installed Capacity(Base Case)

## March,2022



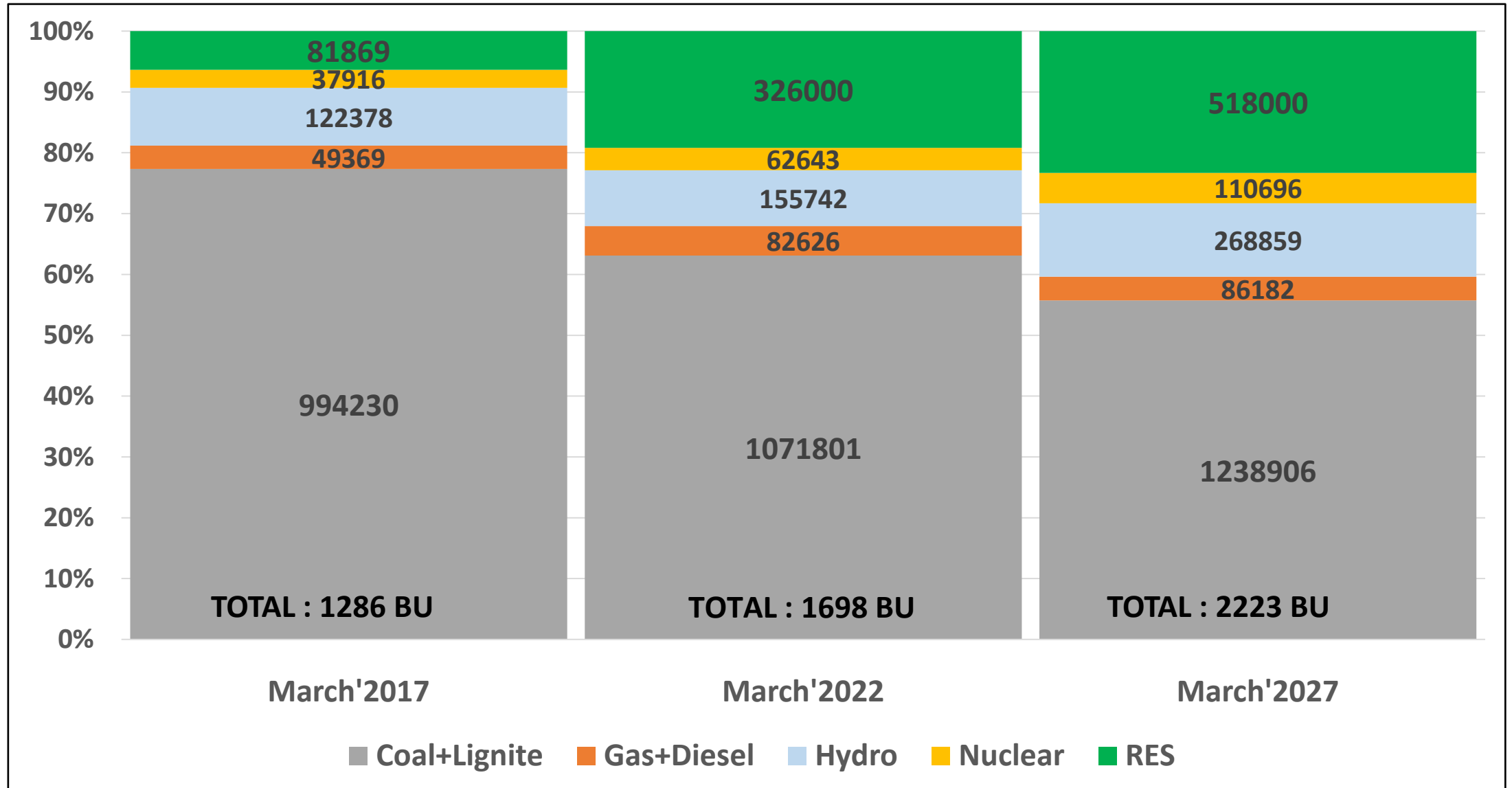
## March,2027



**ALL FIGURES IN MW**

# Projected Gross Generation Mix in the year 2021-22 and 2026-27

( Figures in GWh)



# **COAL REQUIREMENT (2021-22 & 2026-27)**

<b>Description</b>	<b>Unit</b>	<b>2017-18*</b>	<b>2021-22</b>	<b>2026-27</b>
<b>Total Coal based generation</b>	<b>BU</b>	<b>952</b>	<b>1072</b>	<b>1259</b>
<b>Total Coal Requirement</b>	<b>MT</b>	<b>608</b>	<b>735</b>	<b>877</b>

\* Actual figures

# CALCULATION OF CO2 EMISSIONS



## CALCULATION OF CO2 EMISSIONS

$$\text{AbsCO}_2 = 44/12 \times \text{FuelCon} \times \% \text{ Carbon in fuel}$$

Where:

- AbsCO<sub>2</sub> - Absolute CO<sub>2</sub> emission of the station in the year in tonnes
- FuelCon- Amount of fuel of type consumed in the year in tonnes

However as % Carbon in fuel can be obtained by Ultimate Analysis of coal which is expensive and time consuming, Alternate method is adopted

## Emission factors of various fuels in gmCO<sub>2</sub>/MJ

	Emission factors gmCO <sub>2</sub> /MJ
Coal Domestic	90.6
Coal Imported	85.2
Lignite	100.5
Gas	49.4
Diesel	69.1

- Indian coal and lignite emission factors are based on the values provided in India's Initial National Communication under the UNFCCC (Ministry of Environment & Forests, 2004).
- For all other fuels as well as for imported coal, default emission factors were derived from the IPCC 2006 Guidelines

# CALCULATION OF CO2 EMISSIONS FROM POWER STATIONS

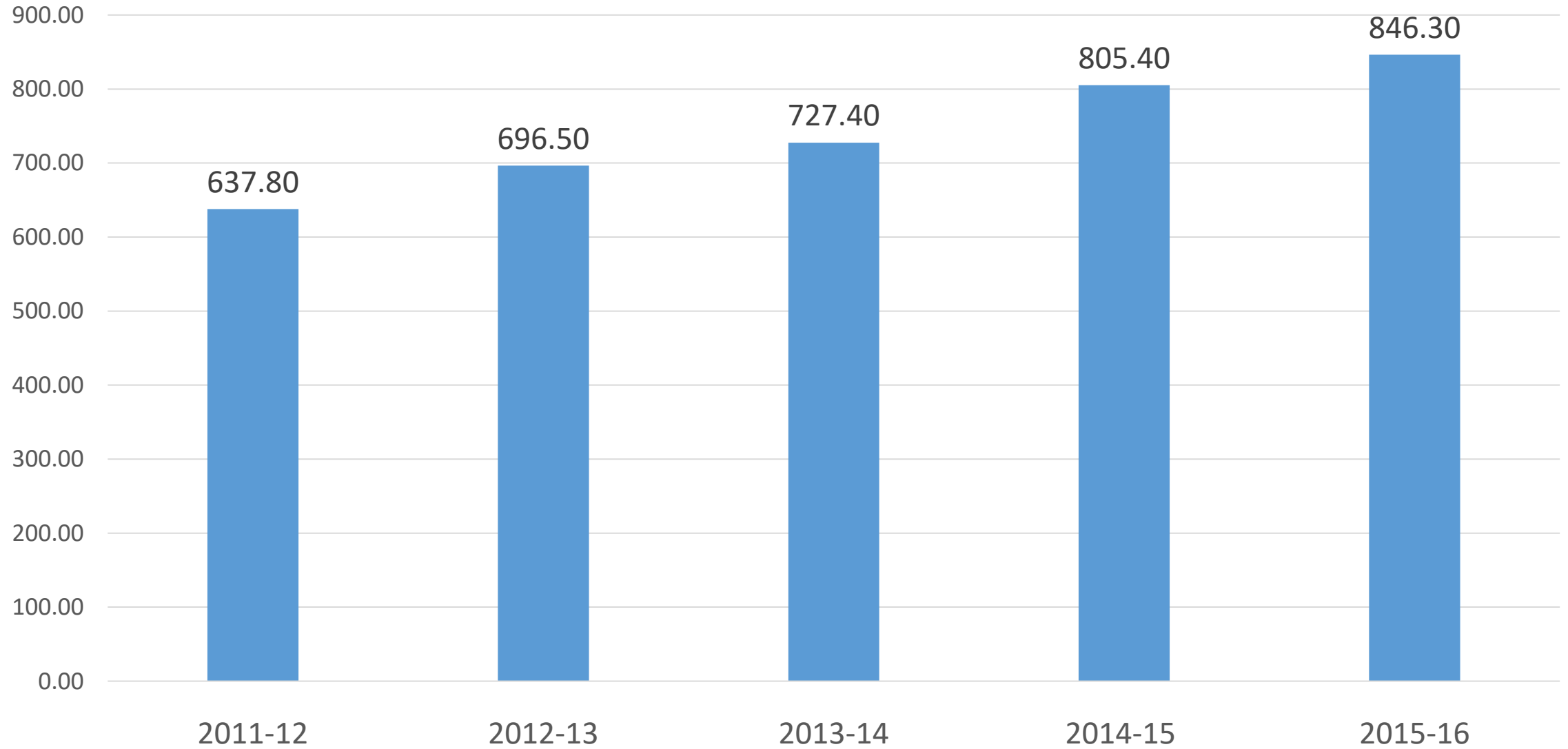
$$\text{AbsCO}_2 = \text{FuelCon} \times \text{GCV} \times \text{EF} \times \text{Oxid}$$

Where:

- AbsCO<sub>2</sub> - Absolute CO<sub>2</sub> emission of the station in the year in tonnes
- FuelCon- Amount of fuel of type consumed in the year in tonnes
- GCV- Gross calorific value of the fuel in the year in MJ/kg
- EF -CO<sub>2</sub> emission factor of the fuel in gmCO<sub>2</sub>/MJ
- Oxid - Oxidation factor of the fuel (0.98 for coal)

## PRESENT STATUS OF CO2 EMISSIONS

## TOTAL ACTUAL CO2 EMISSIONS FROM POWER SECTOR IN MILLION TONNES



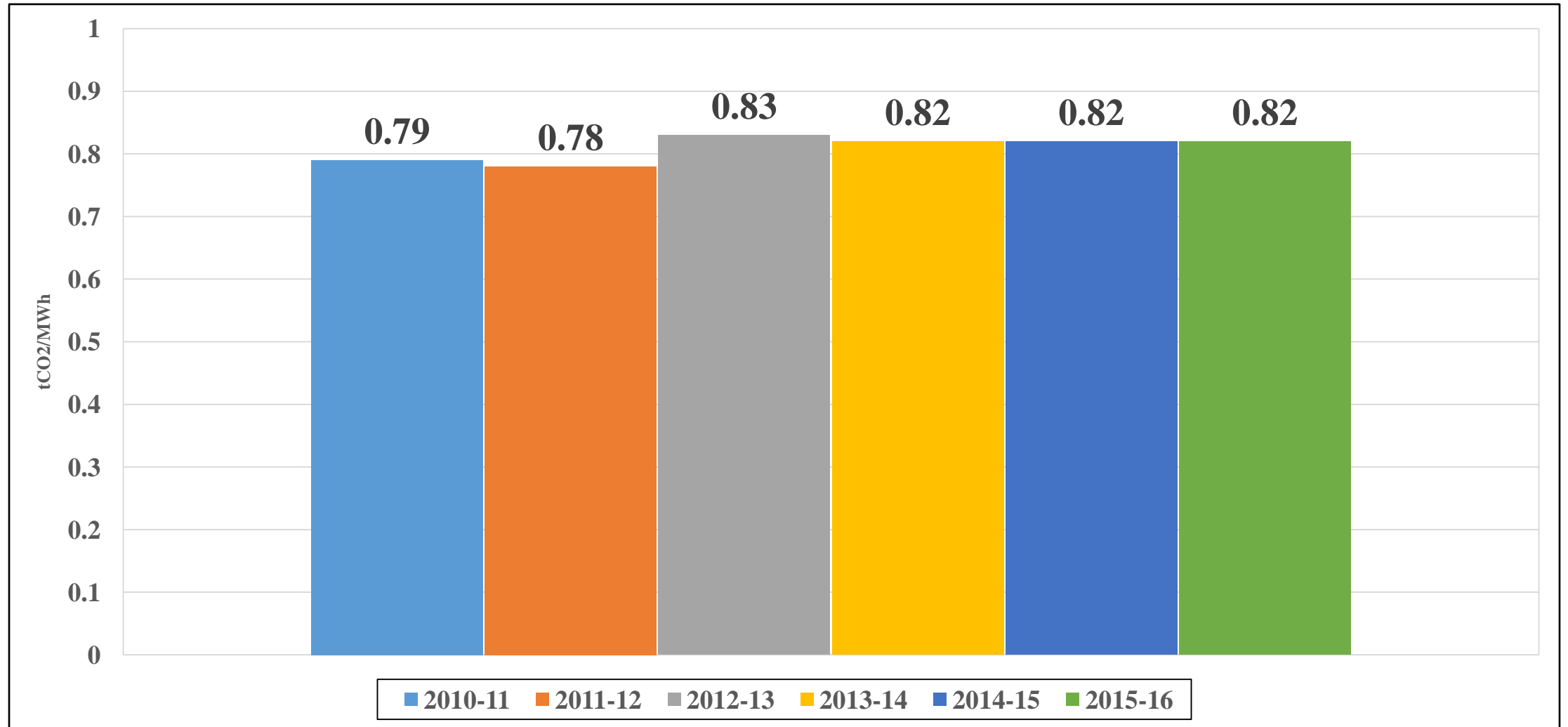
CAGR (2011-12 to 2015-16) --- 7.33%

## Weighted Average Emission Factor:

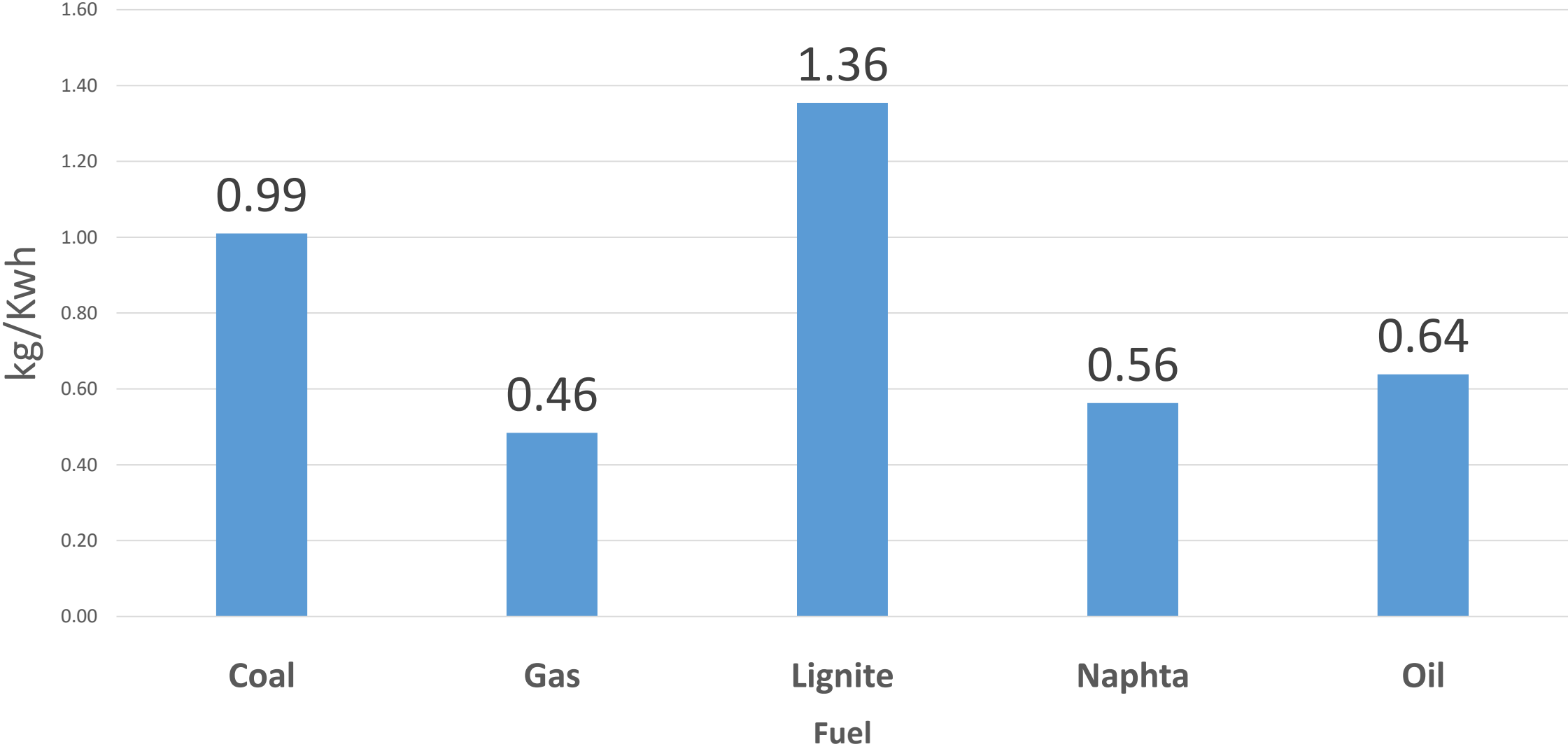
The weighted average emission factor describes the average CO<sub>2</sub> emitted per unit of electricity generated in the grid. It is calculated by dividing the absolute CO<sub>2</sub> emissions of all power stations by the total generation from all sources.

# Weighted Average Emission factor in tCO<sub>2</sub>/MWh(net)

From conventional sources only



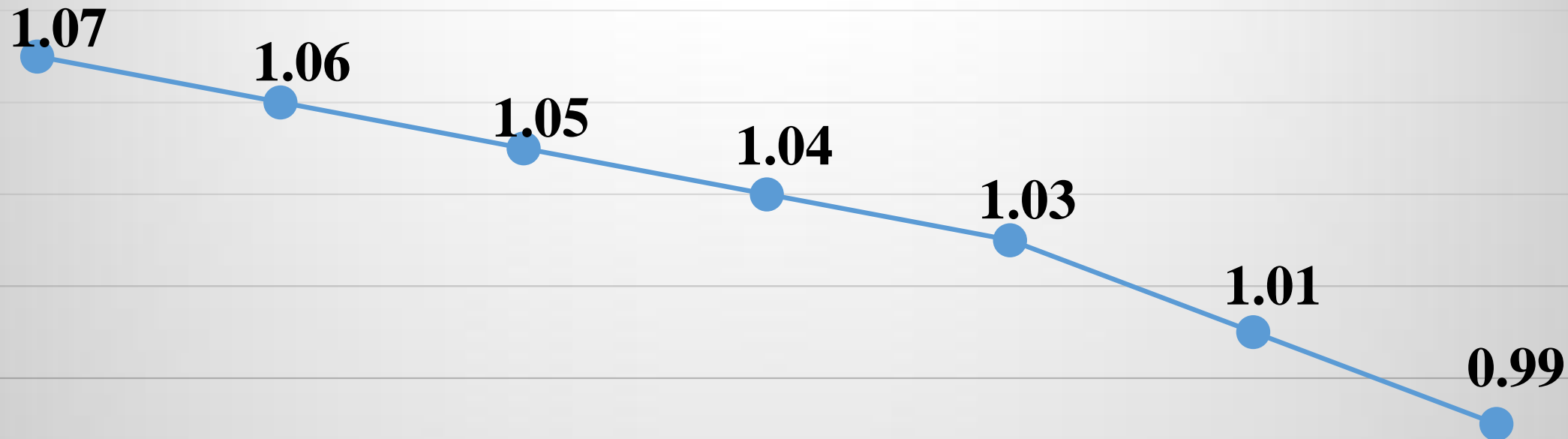
# CO2 Emissions per kwh(net) from various fuels in 2015-16



Figures are on Net Generation



**AVERAGE EMISSION RATE FROM COAL BASED POWER STATIONS IN  
KGCO<sub>2</sub>/KWH NET**



**2009-10**

**2010-11**

**2011-12**

**2012-13**

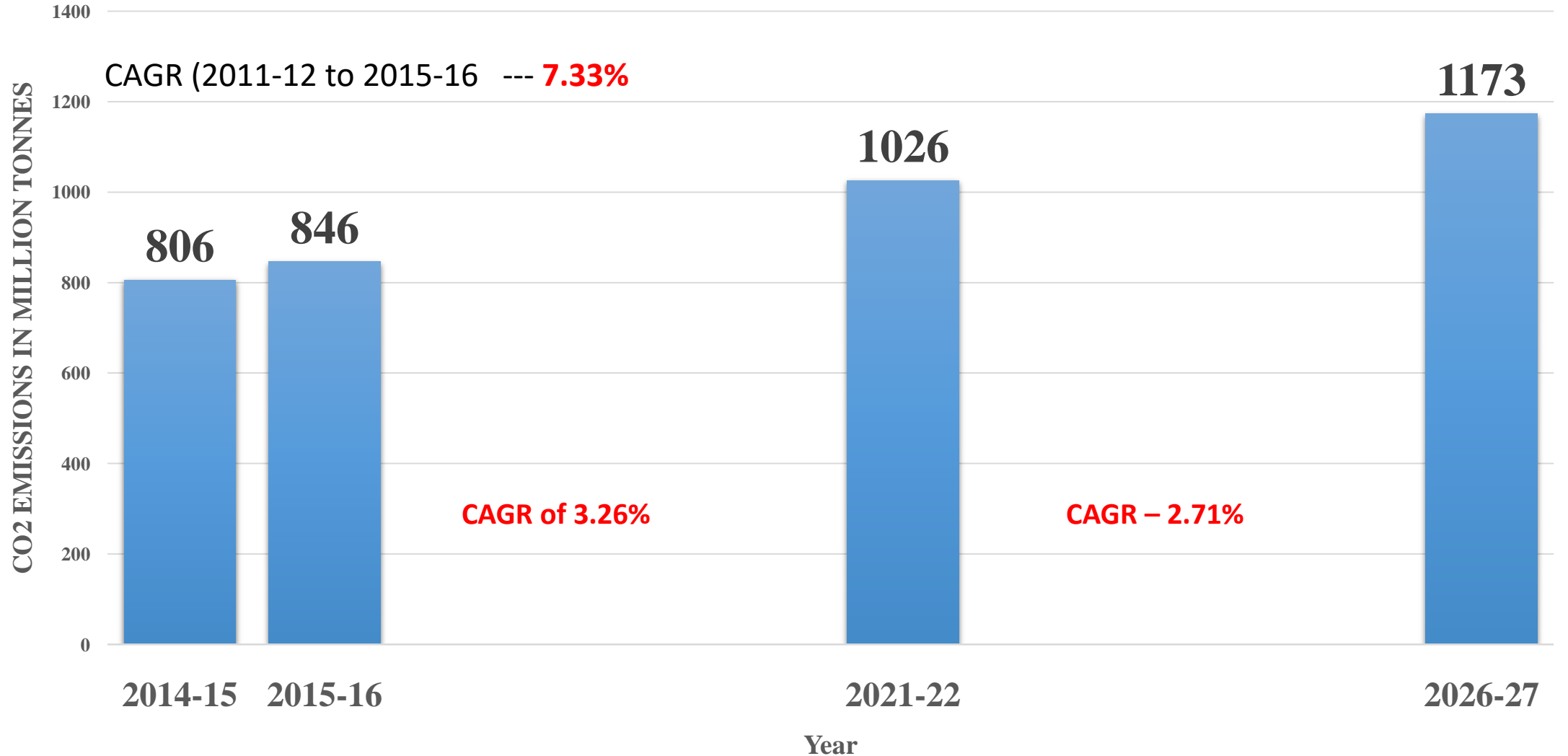
**2013-14**

**2014-15**

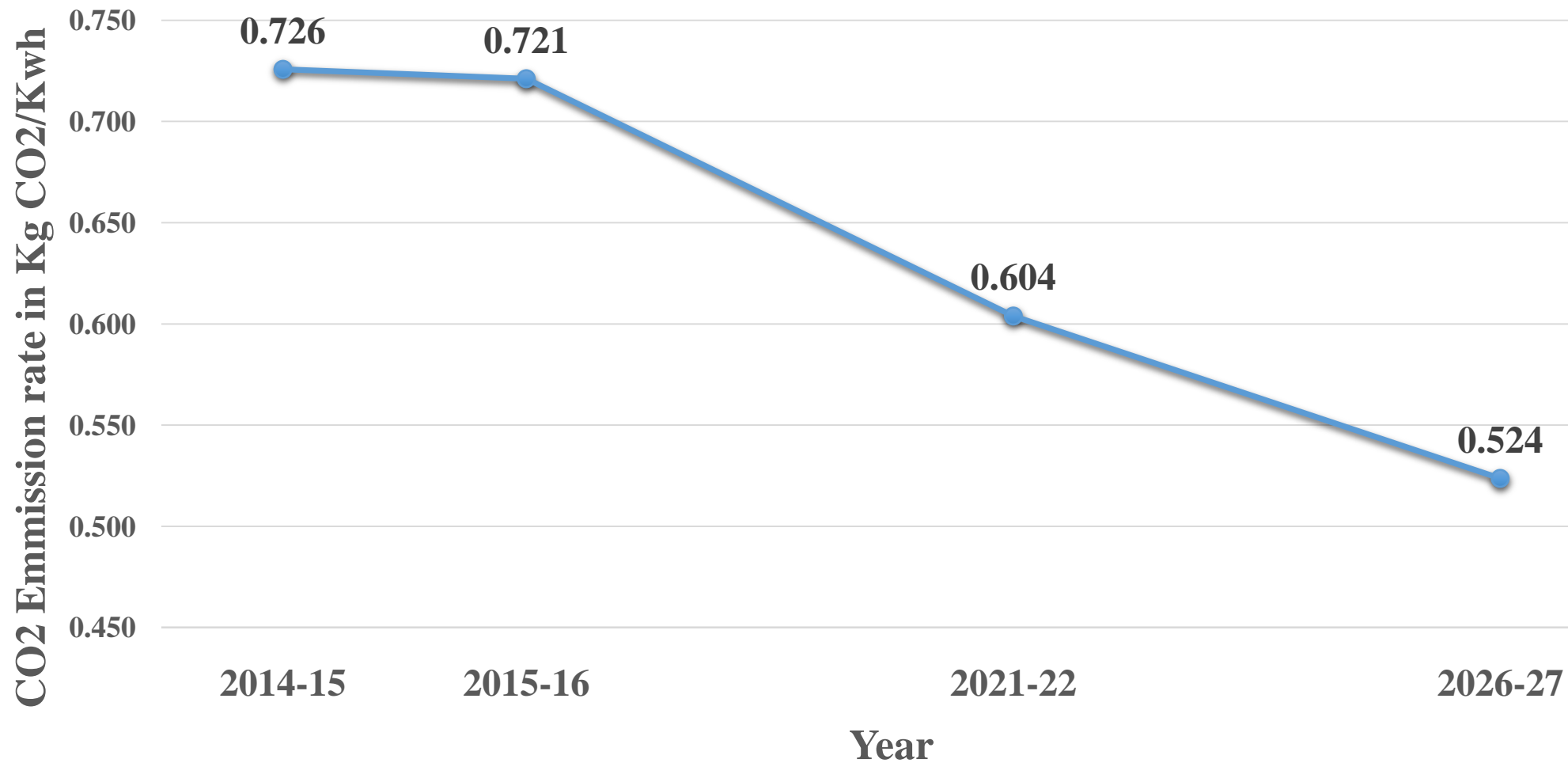
**2015-16**

# FUTURE PROJECTIONS OF CO2 EMISSIONS

# TOTAL PROJECTED CO2 EMISSIONS FROM POWER SECTOR IN MILLION TONNES



## AVERAGE CO2 EMISSION RATE GROSS IN 2022 and 2027



Considering Generation from all sources including RES

# INITIATIVES OF GOVERNMENT OF INDIA TO REDUCE CARBON EMISSIONS

- Improving efficiency of thermal power stations
  - Perform Achieve and Trade Scheme under National Mission on Energy Efficiency
  - Adopting super critical/ultra-super critical technology for coal based generation.
  - Efficiency improvement measures through Renovation and Modernization
  - Retirement of old and inefficient units.
- Thrust is being given for increasing the share of non-fossil fuel (renewable, hydro etc.) based generation in the energy-mix
- Various Energy Efficiency Measures like LEDs, Star labelling etc.

## Impact of PAT Scheme Cycle -I (2012-15) on CO<sub>2</sub> emissions

A	Total Notified Thermal Power Plants	144
B	Total Energy Consumption (MTOE)	104
C	Target (MTOE)	3.21
D	Achieved (MTOE)	3.06
E	CO <sub>2</sub> emission reduction in Million Tonnes	11.6

# Impact on CO2 Emission with Heat Rate

<b>Heat Rate kcal/kwh</b>	<b>2250</b>	<b>2350</b>
<b>CO2 Emission factor gmCO2/MJ</b>	<b>90.6</b>	<b>90.6</b>
<b>CO2 emission in kg/kwh</b>	<b>0.854</b>	<b>0.891</b>
<b>Generation 500 MW coal unit @70% PLF in MU</b>	<b>3066</b>	<b>3066</b>
<b>CO2 Emissions in '000 tonnes</b>	<b>2616.89</b>	<b>2733.20</b>
<b>Increase in CO2 Emissions in '000 tonnes</b>	<b>116.31</b>	

## Impact of Supercritical technology based units on CO<sub>2</sub> emissions

A	Total Generation capacity added from Supercritical units as on 31.3.2017	41,310 MW
B	Total actual gross generation from Supercritical units during 2016-17 in Million Units	559,314.6 MU
C	Business as usual :500 MW subcritical: estimated CO <sub>2</sub> emission (Kg CO <sub>2</sub> /kwh Gross) [based on designed heat rate]	0.853
D	Super Critical Units: Estimated CO <sub>2</sub> emissions (Kg CO <sub>2</sub> /kwh Gross) [based on designed heat rate]	0.816
E	CO <sub>2</sub> emission reduction {(C-D)/1000 x B in Million Tonnes	$\frac{(0.037^*/1000) \times 559,314.6}{1000} = 20.69$ Million Tonnes



# IMPACT ON CO<sub>2</sub> EMISSIONS DUE TO HUGE CAPACITY ADDITION FROM RENEWABLE ENERGY SOURCES

Year	Installed capacity of RES (GW)	Expected Generation in (BU)					Savings in CO <sub>2</sub> emissions @ Grid Emission factor of 0.82 kg/kwh*
		Solar	Wind	Biomass	SHP	Total	
2021-22	175	162	112	37	15	326	268 Million tonnes
2026-27	275	243	188	63	24	518	425 Million tonnes

\*However, the net reduction of CO<sub>2</sub> emissions will be less as emissions from thermal power stations will increase due to frequent cycling and ramping of the plants than during steady state operation about 2-4% more.

# IMPACT ON CO<sub>2</sub> EMISSIONS DUE TO VARIOUS DEMAND SIDE MEASURES

Year	Estimated Energy Savings in BU	Savings in CO <sub>2</sub> emissions @ Grid Emission factor of 0.82 kg/kwh*
2021-22	206	169 Million tonnes
2026-27	273	224 Million tonnes

DSM measures include Star labelling, Bachat lamp yojna, Agricultural DSM etc

**India's Intended Nationally Determined Contribution (INDC)**  
**40 % cumulative power installed capacity from non-fossil fuels by 2030.**

<b>Year</b>	<b>Likely IC (GW)</b>	<b>Likely IC of Fossil Fuel (GW)</b>	<b>Likely IC of Non-Fossil Fuel (GW)</b>	<b>% of Non-Fossil Fuel in IC</b>
<b>March 2022</b>	<b>479.4</b>	<b>243.0</b>	<b>236.4</b>	<b>49.3%</b>
<b>March 2027</b>	<b>619.0</b>	<b>263.9</b>	<b>355.1</b>	<b>57.4%</b>

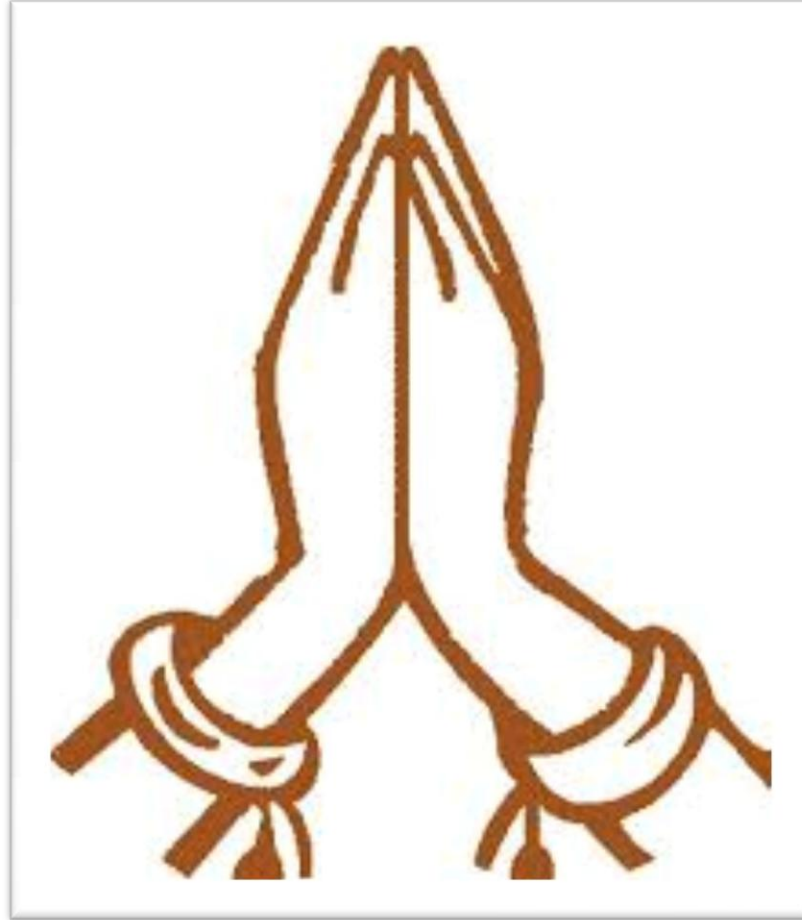
Presently share of non fossil is 35% in the IC 31.3.2018

## India's Intended Nationally Determined Contribution (INDC)

To reduce the emissions intensity of its GDP by 33% to 35 % by 2030 from 2005 level

### Projected CO<sub>2</sub> emissions Intensity reduction from Power Sector only

	Years		
	2005	2022	2027
Emission intensity kg/₹ GDP	0.015548	0.009249	0.007207
% Reduction in emission intensity base 2005		40.51	53.65



**THANK YOU**



# TYPICAL ALL INDIA DEMAND & NET LOAD CURVE (2021-22)

