

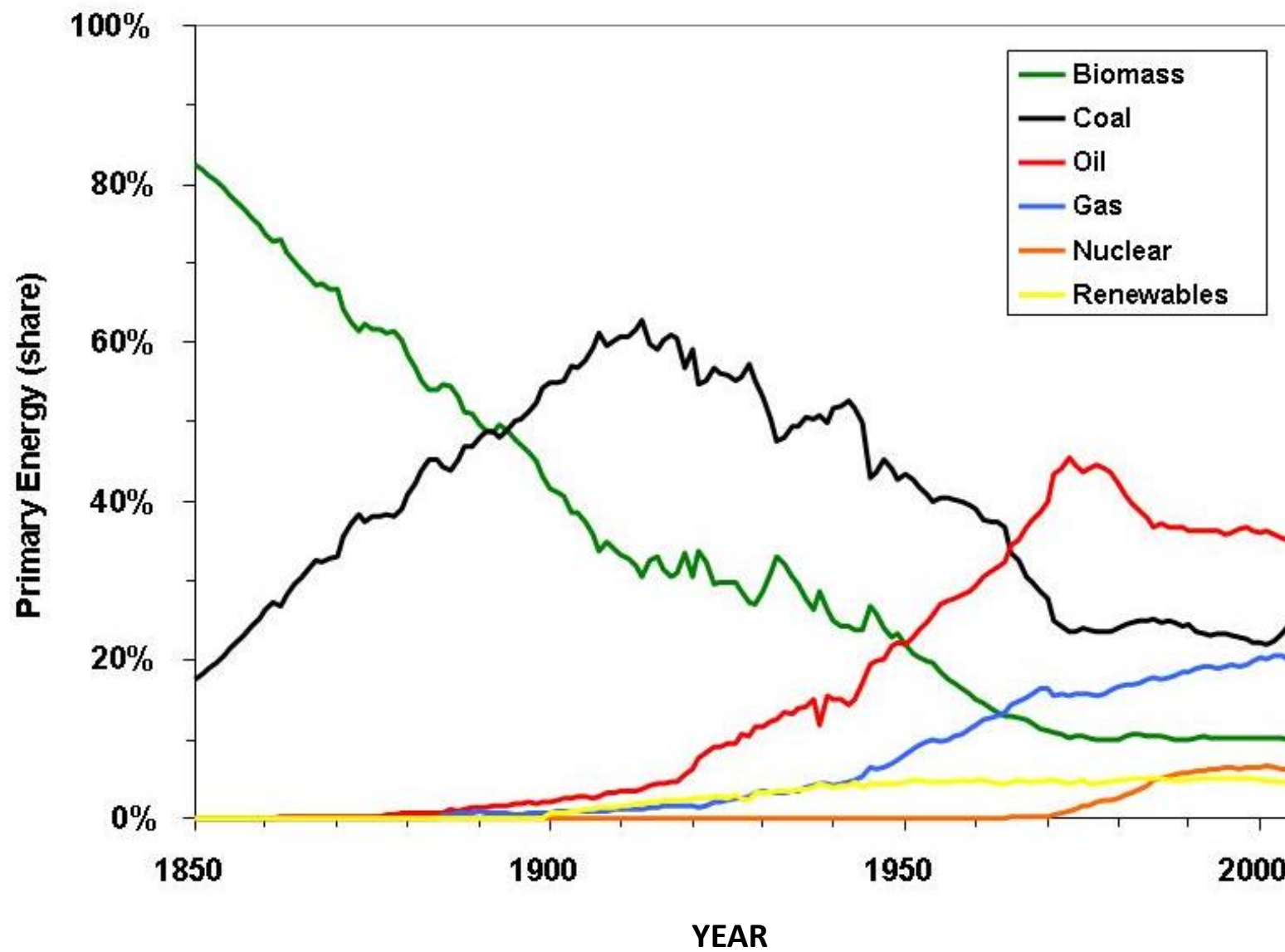
Reunião Anual do Programa FAPESP de pesquisa sobre Mudanças Climáticas Globais 2019

Energia

Professor José Goldemberg

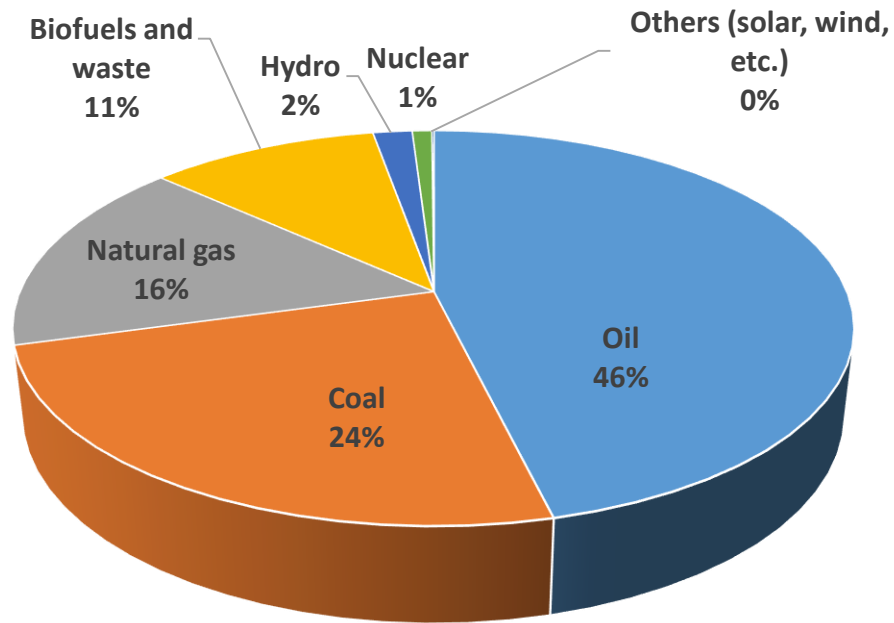
21/02/2019

Evolução da matriz energética mundial
1850-2010



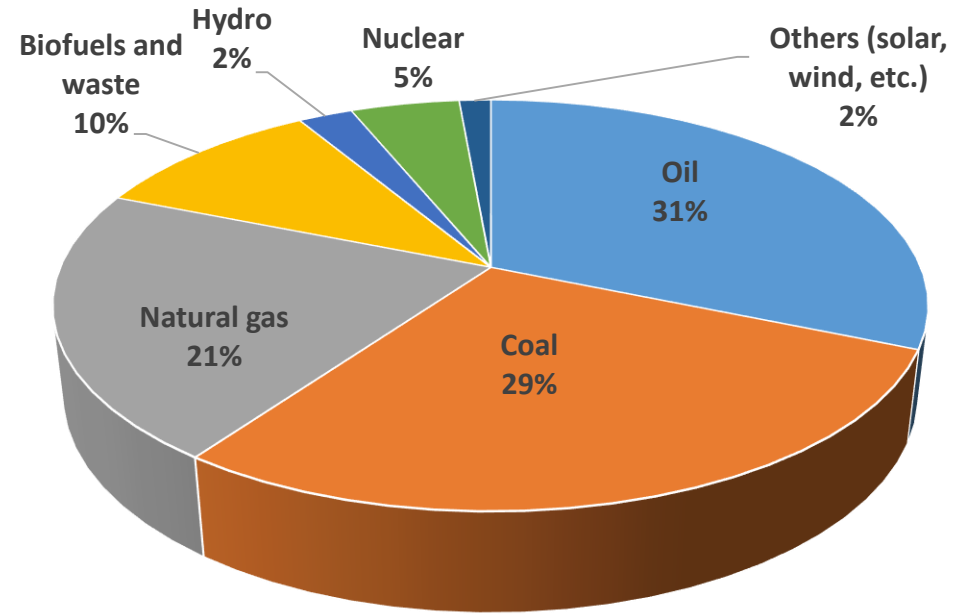
The world's energy matrix

1973



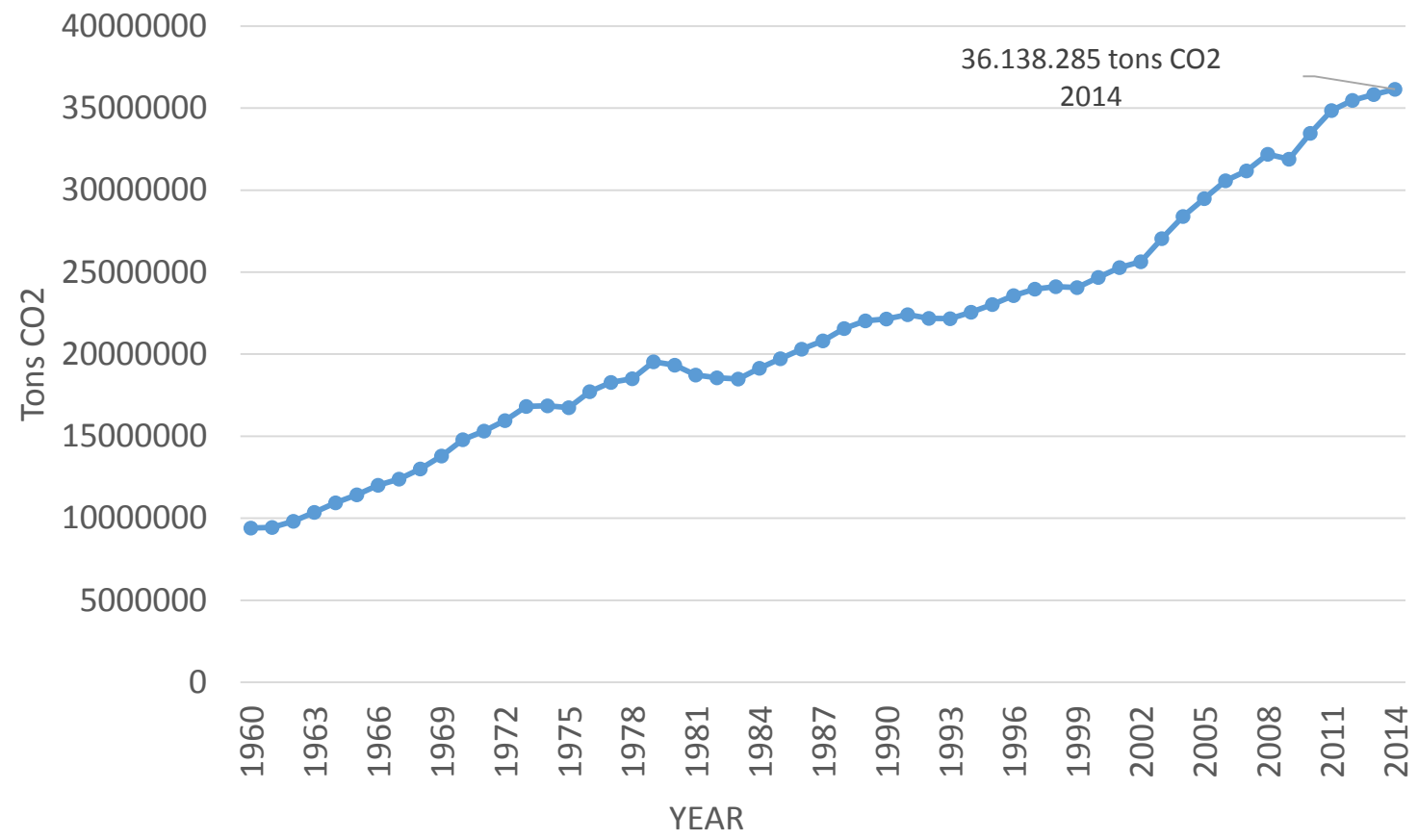
Fossil fuels: 86%

2014

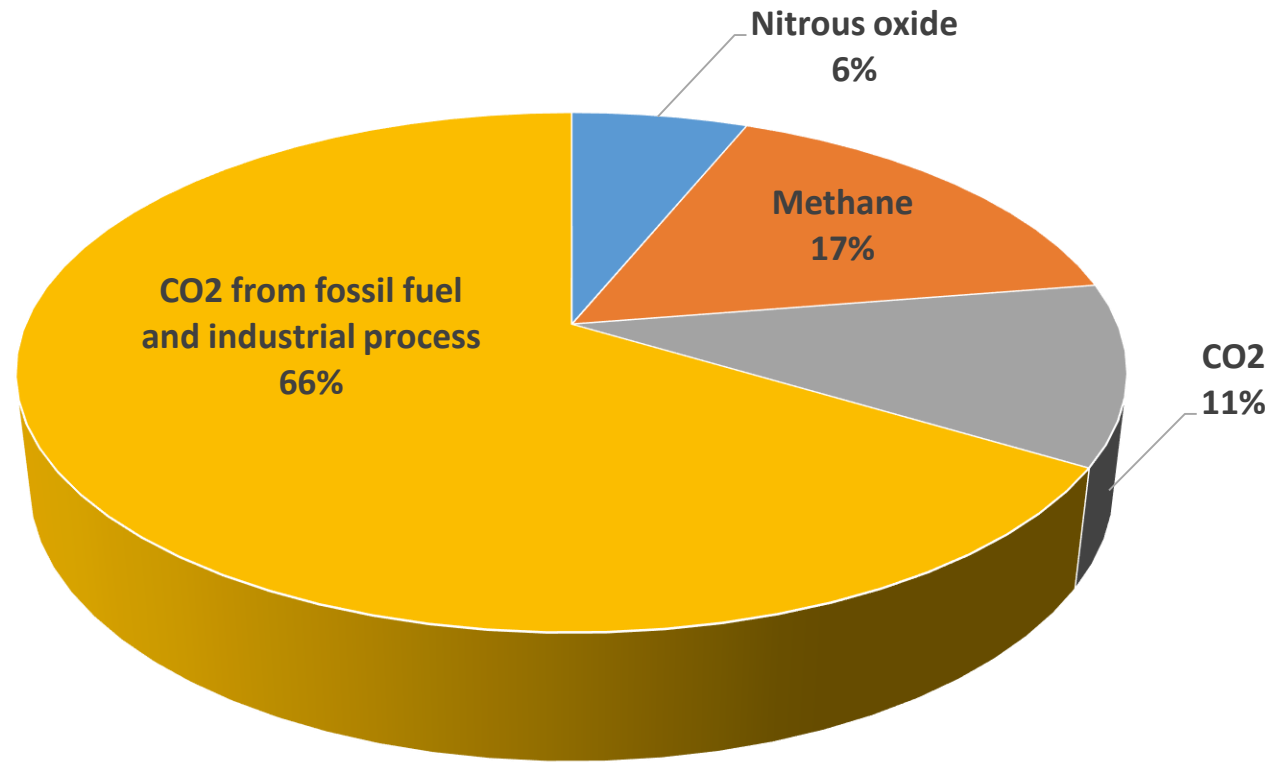


Fossil fuels: 82%

World
CO₂ emissions (1960-2014)



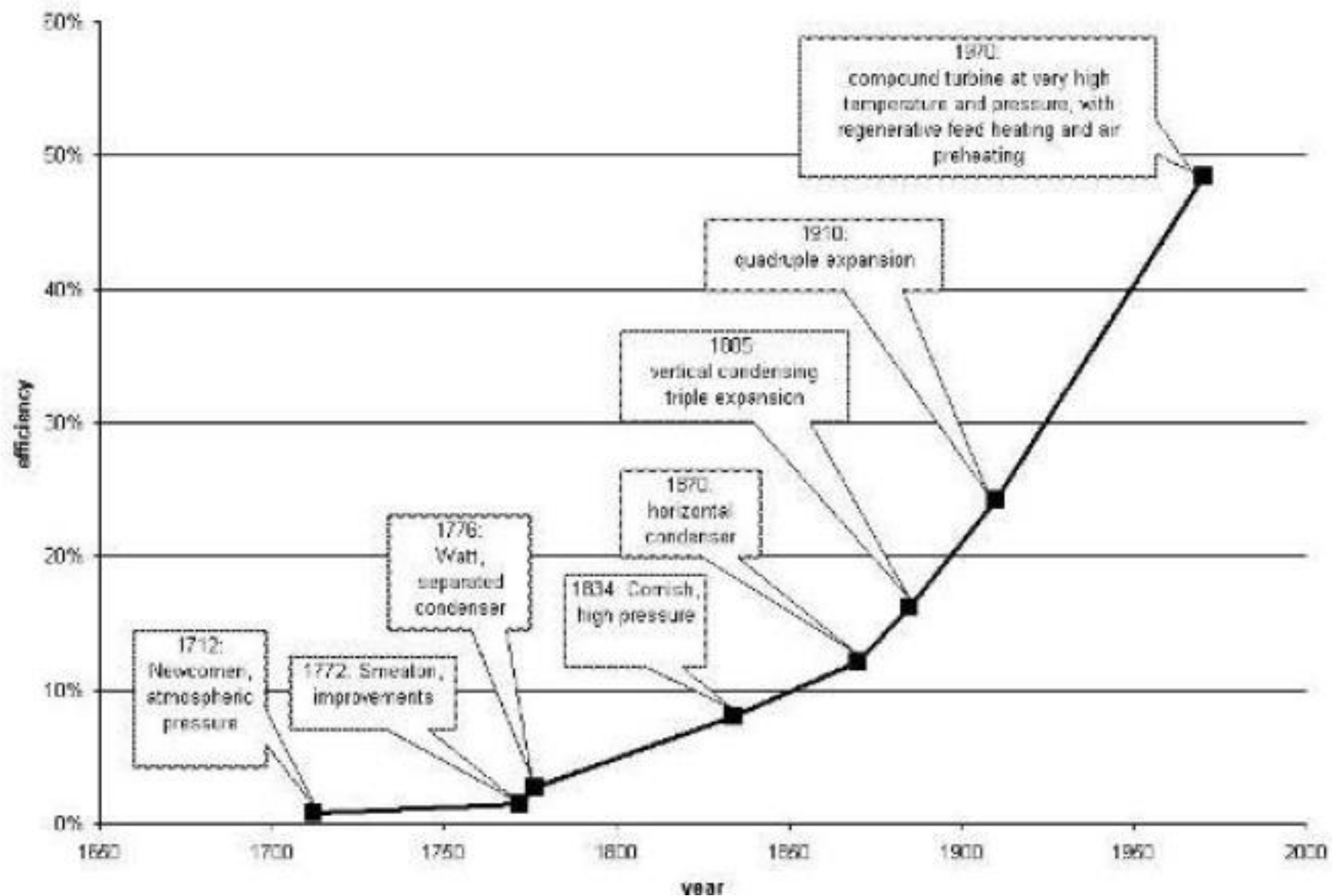
**Carbon Emissions
World
2014**



“DRIVERS” da redução de emissões de carbono

- Avanço tecnológico/competição na eficiência das máquinas térmicas;
 - Aumento na produção de eletricidade;
 - Redução da poluição local;
 - Redução do consumo de água;
- Energias renováveis;
- Aumento da eficiência dos equipamentos de uso final e
- Mudanças nos padrões de consumo

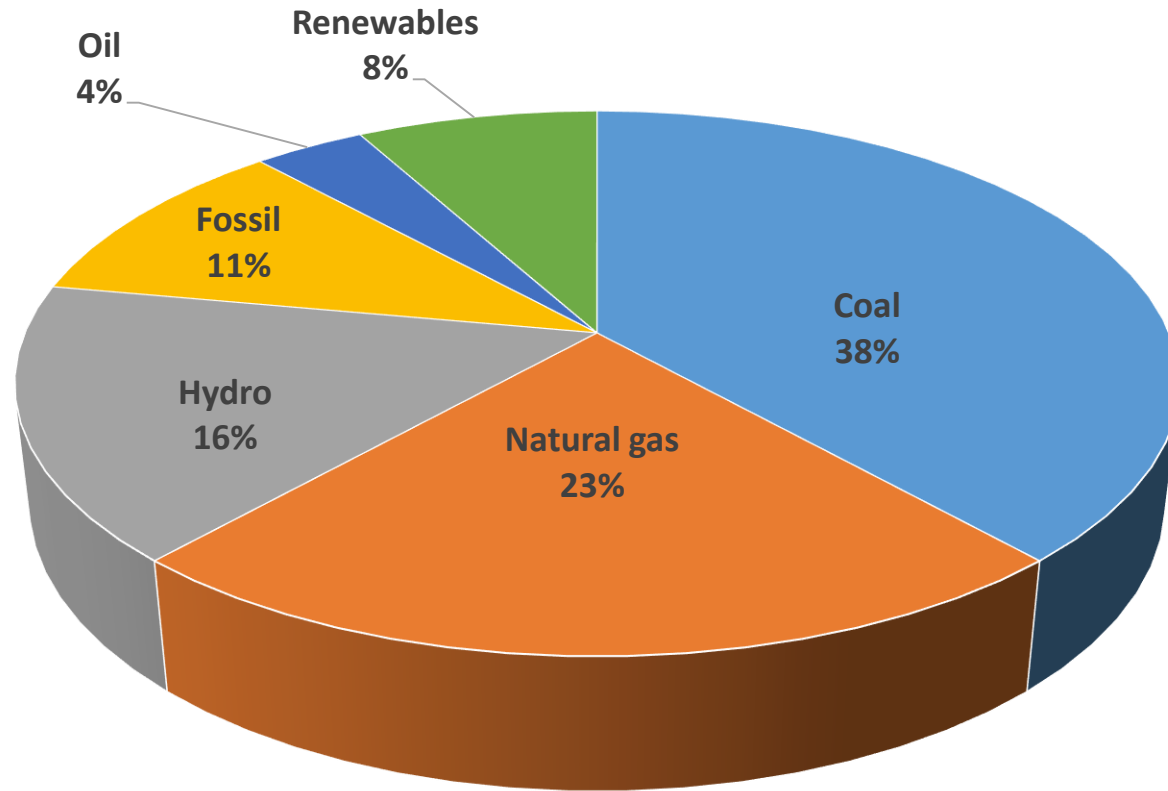
Evolução da eficiência da maquina de Watt



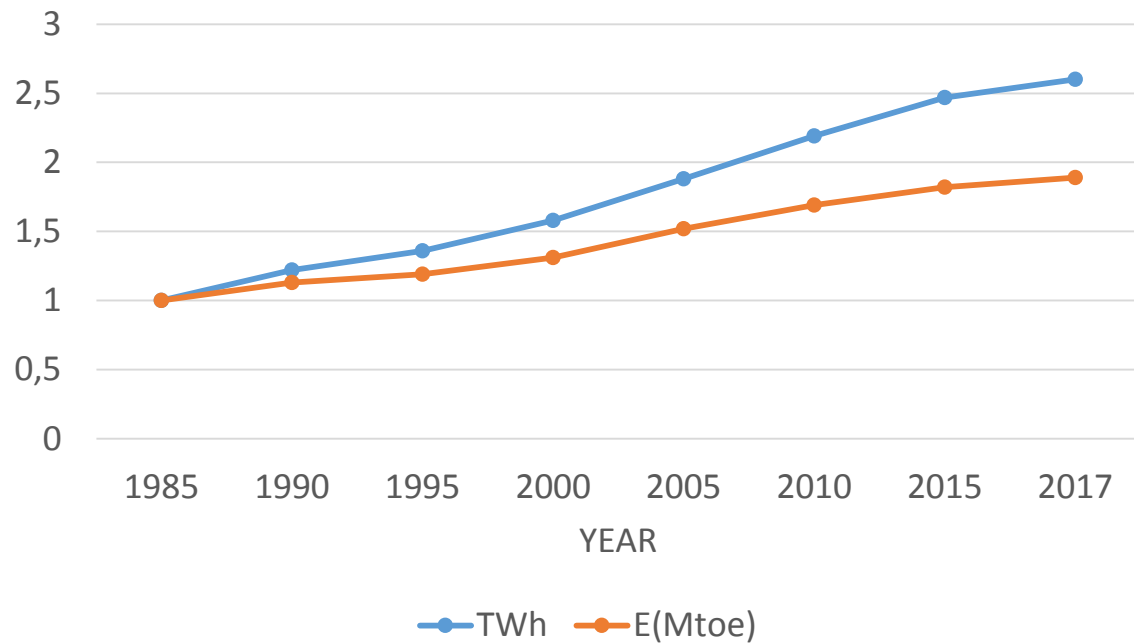
Average sulphur content of various fuels

FUEL	AVERAGE SULPHUR CONTENT
UK coal	1.6%
Imported coal	0.8-1.0%
Oil	2.9%
Gas	Trace

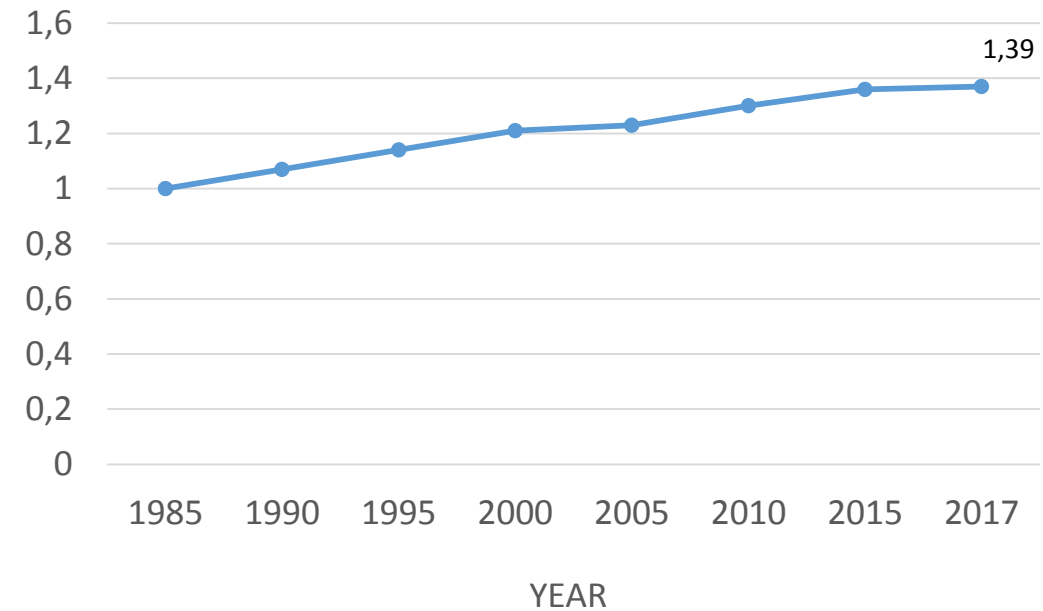
World Electricity Generation TWh 2014

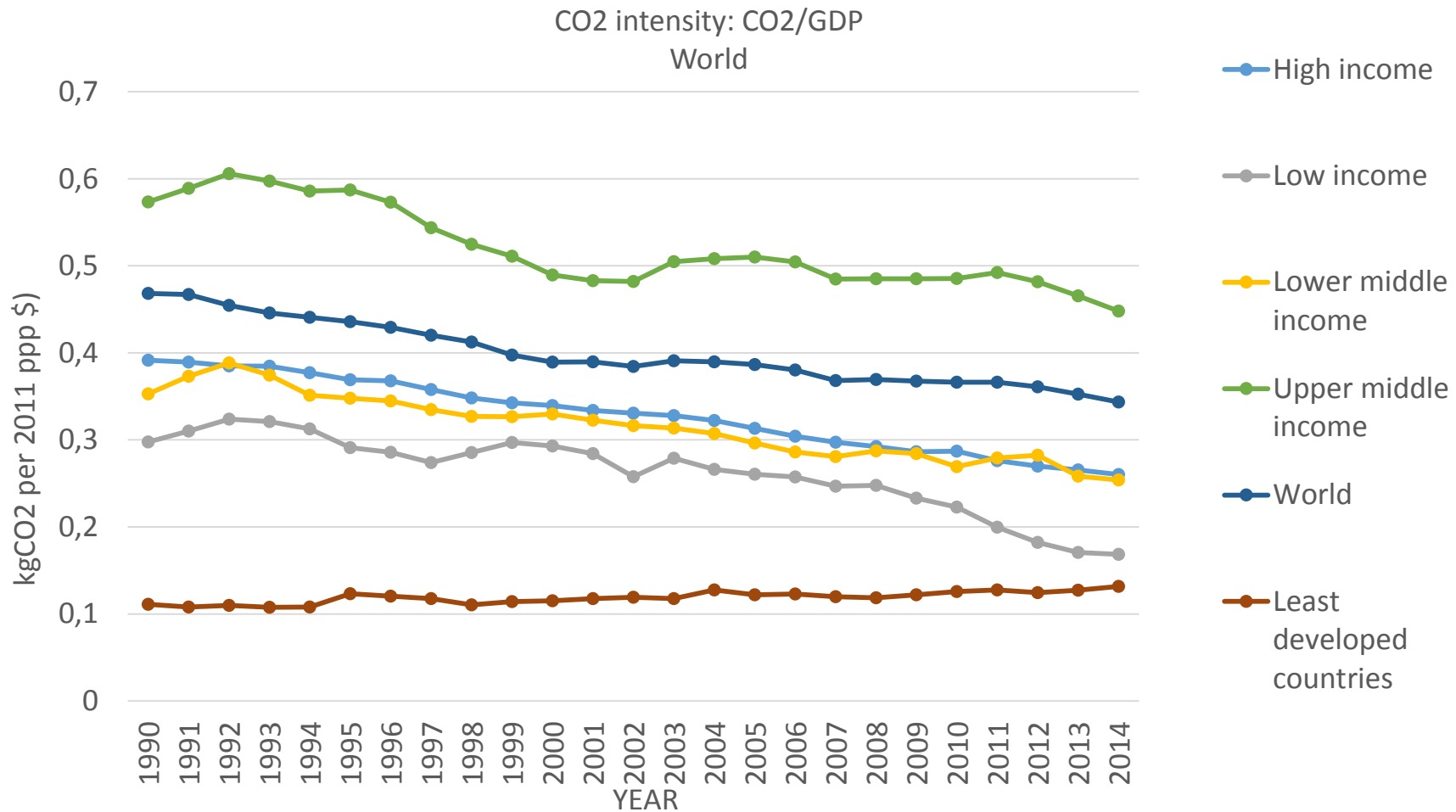


Evolução da produção de eletricidade e do consumo total de energia



kWh/toe



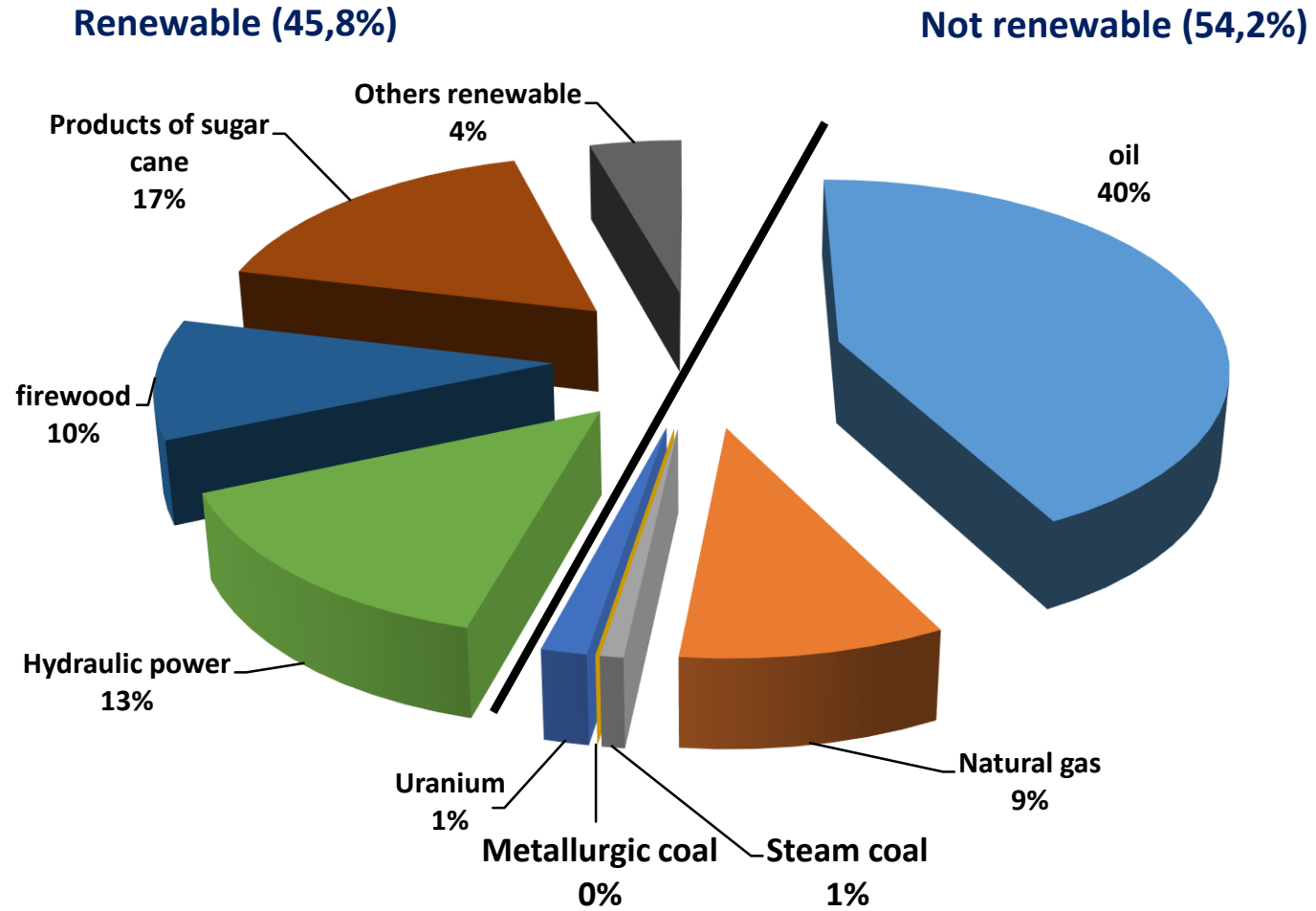


Low income	<US\$ 1005
Lower middle income	US\$ 1005 – US\$ 3955
Upper middle income	US\$ 3956 – US\$ 12.235
High income	> US\$ 12.235

Classificação dos países

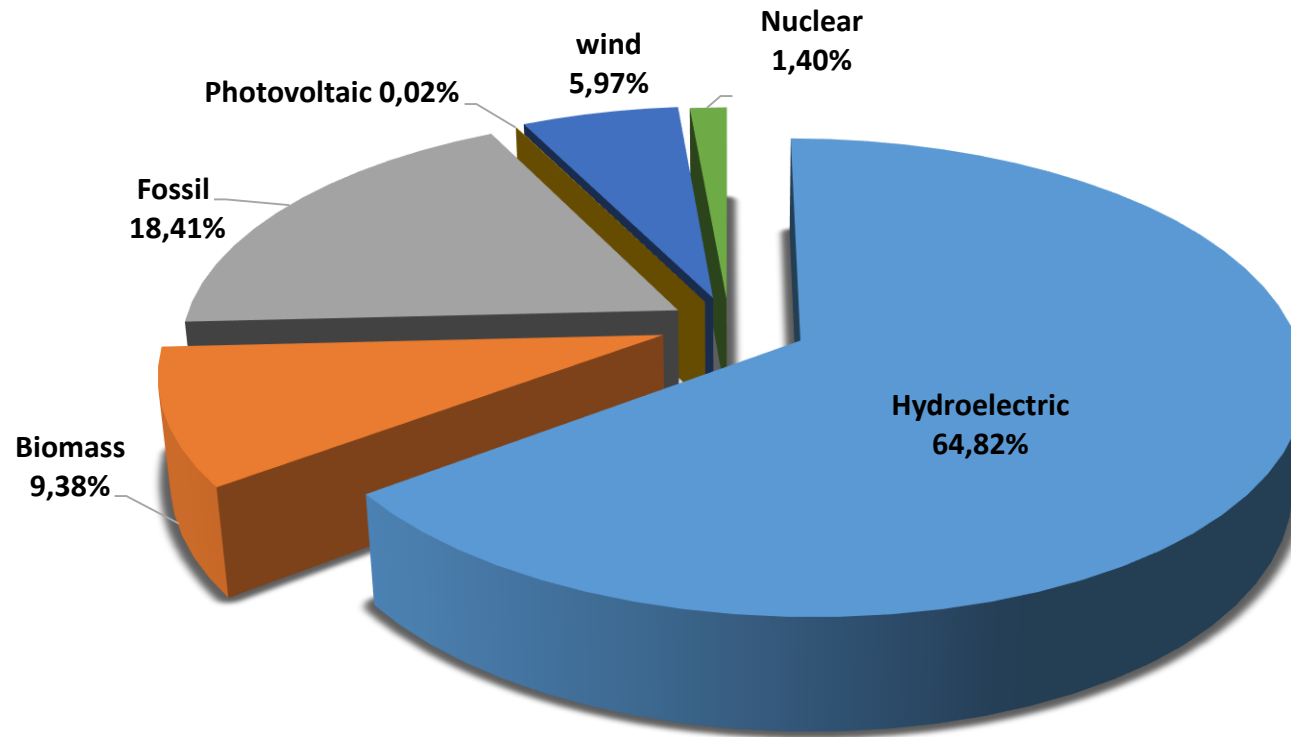
Grupo de países	% das emissões de CO ₂
Low and middle income	58.1
Low income	0.76
Lower middle income	11.6
Middle income	57.5
Upper middle income	45.9
WORLD	100 (36.138.285 tons)
Least developed countries UN classification	0.81
Low income	<US\$ 1005
Lower middle income	US\$ 1005 – US\$ 3955
Upper middle income	US\$ 3956 – US\$ 12.235
High income	> US\$ 12.235

Brazilian Energy Matrix (2014)



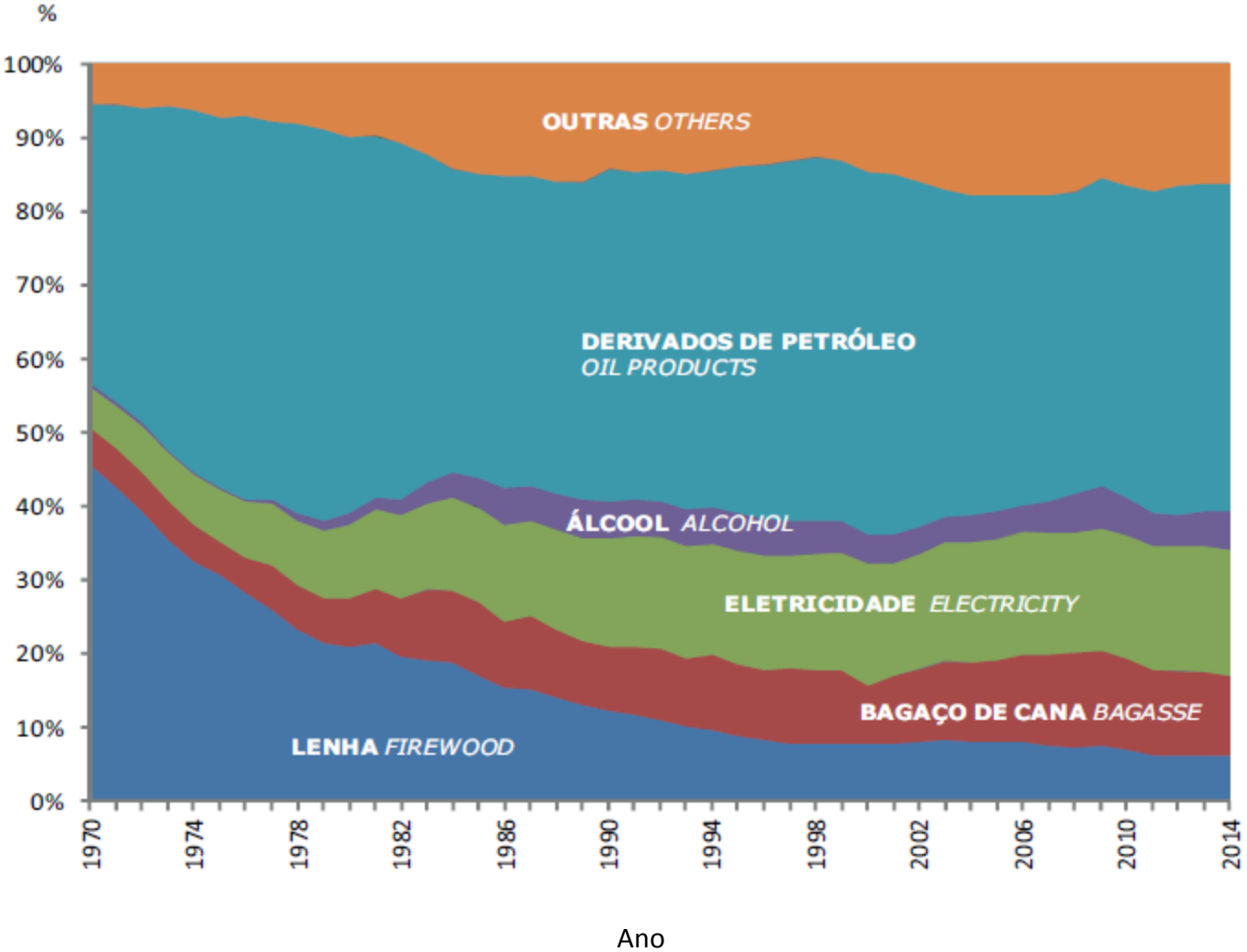
Electricity in Brazil 2015

142,2 GW

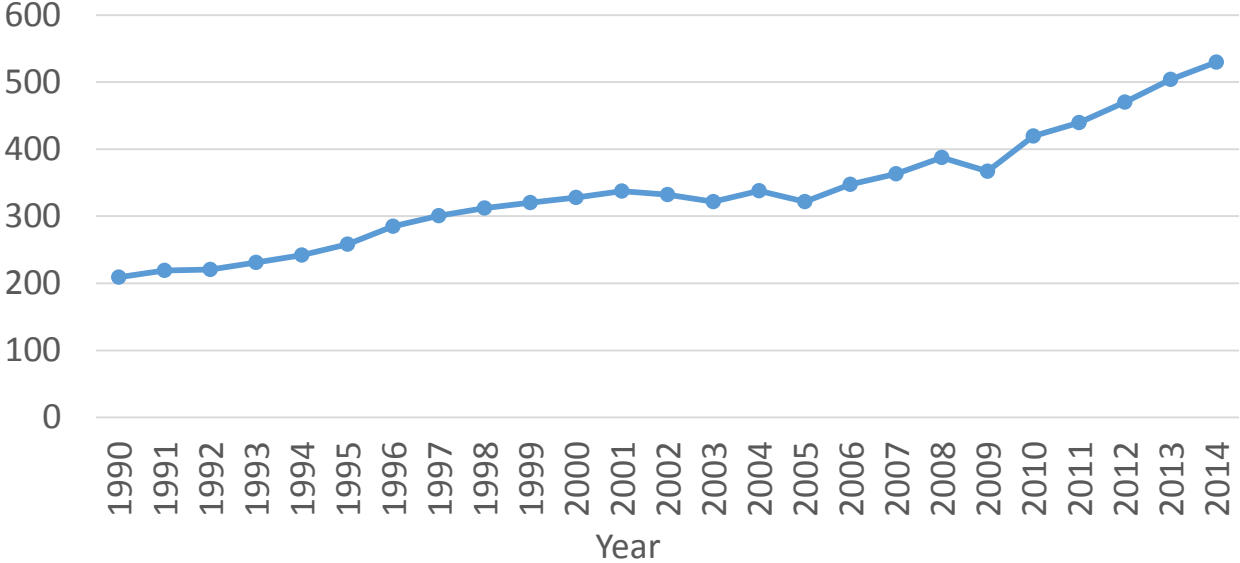


Brasil

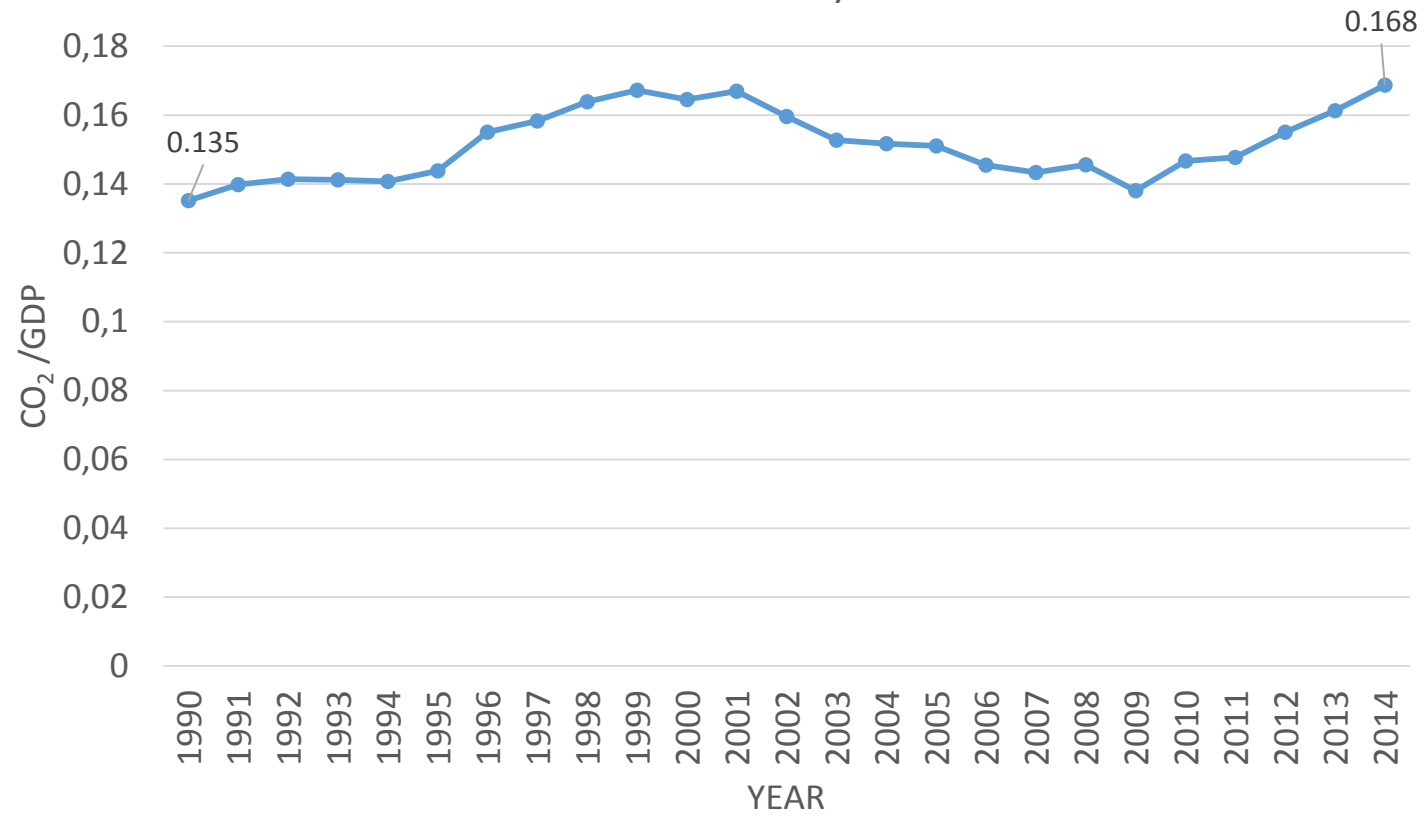
Evolução do consumo de energia (1970-2014)



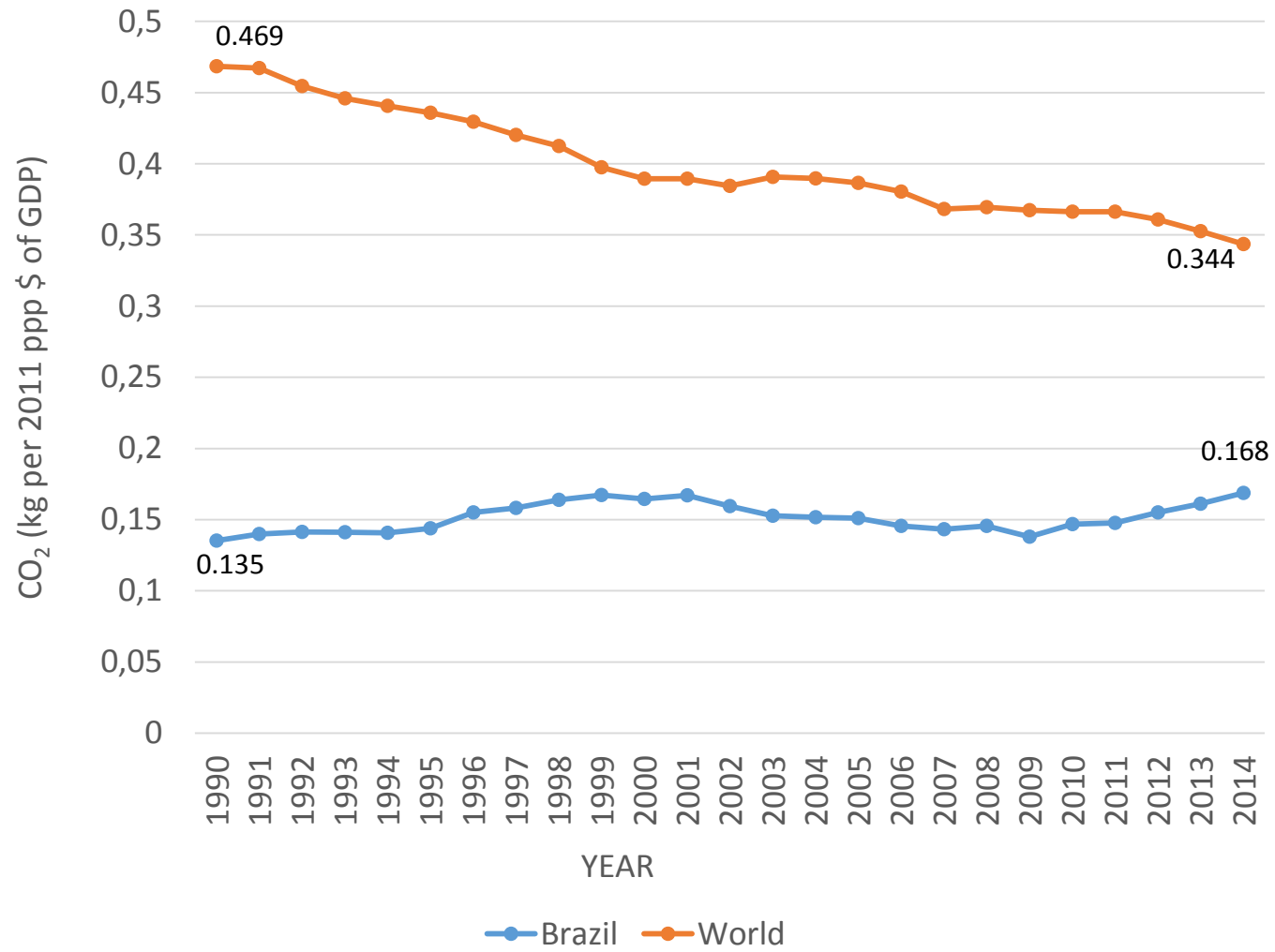
CO2 emissions (ktons)
Brazil



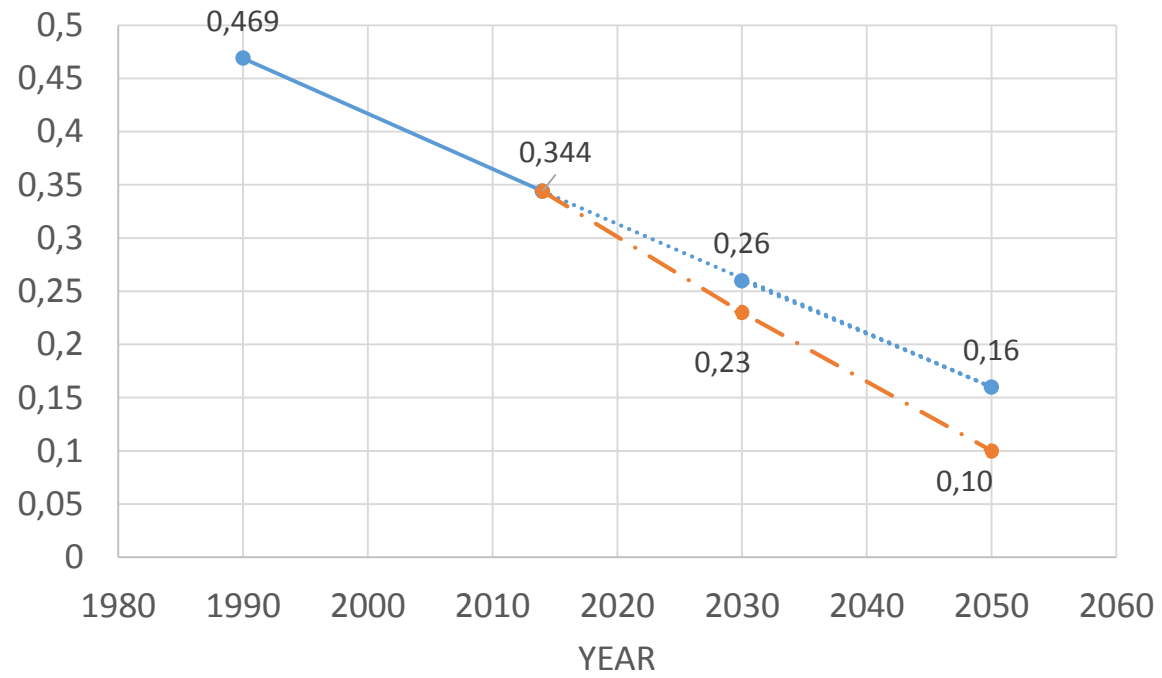
Brasil Carbon intensity



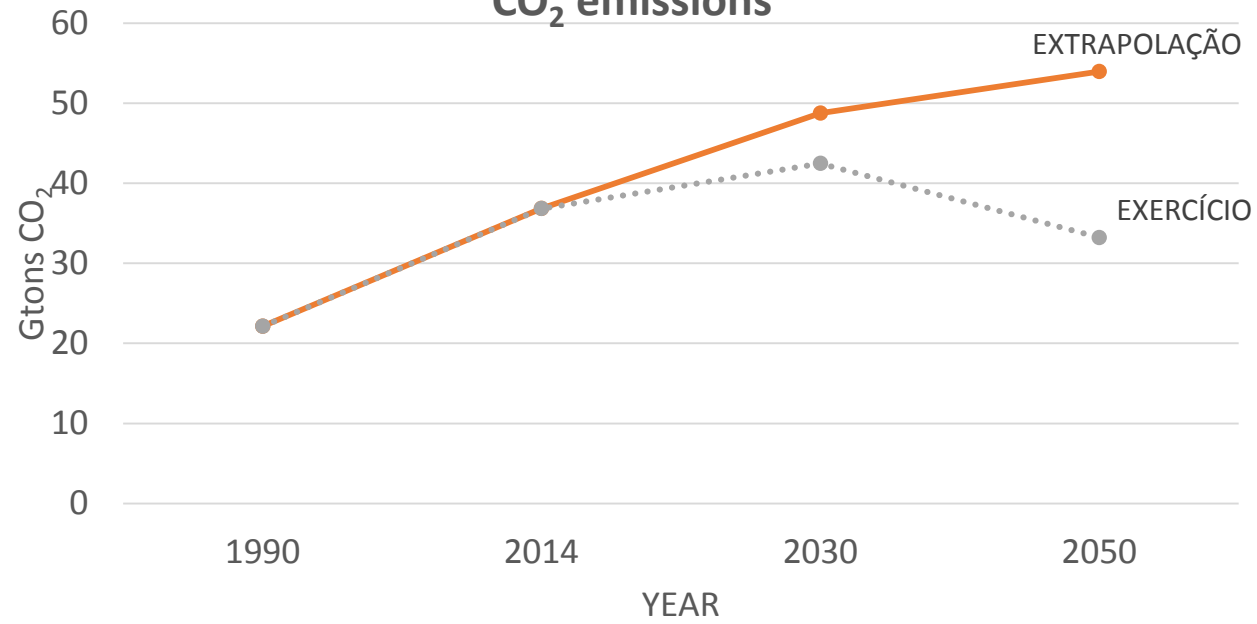
Carbon intensity: CO₂/GDP



World Carbon Intensity (CO₂/GDP)



World CO₂ emissions



$$C = \frac{C}{GDP} \times GDP \quad \frac{C}{GDP} = Ic$$

$$\frac{\Delta C}{C} = \frac{\Delta \frac{C}{GDP}}{\frac{C}{GDP}} + \Delta GDP$$

$$\frac{\Delta C}{C} = \frac{\Delta Ic}{Ic} + \Delta GDP$$