Global Electric Power Sector: Engaging with Environmental Issues

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INVITED SPEECH

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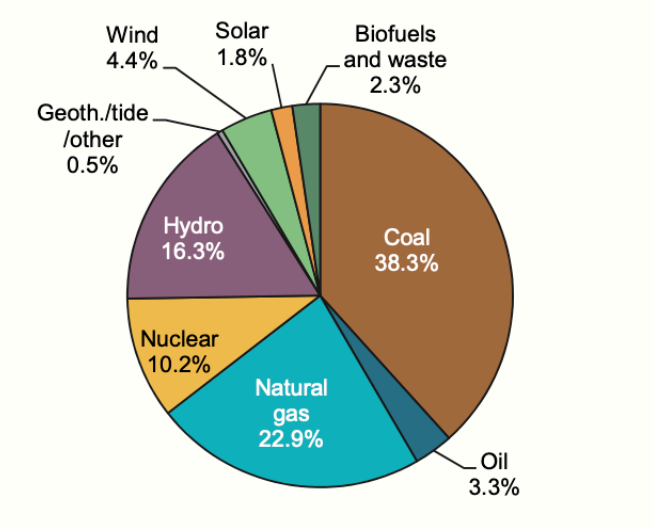
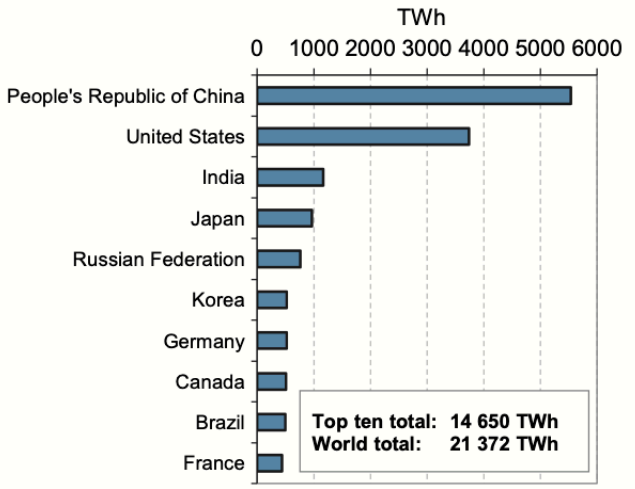
World Gross Electricity Production in 2017 by Source 25,721 TWh



Source: IEA Electricity Information Overview 2019

Top 10 Electricity Consuming Countries in 2017 TWh



Source: IEA Electricity Information Overview 2019

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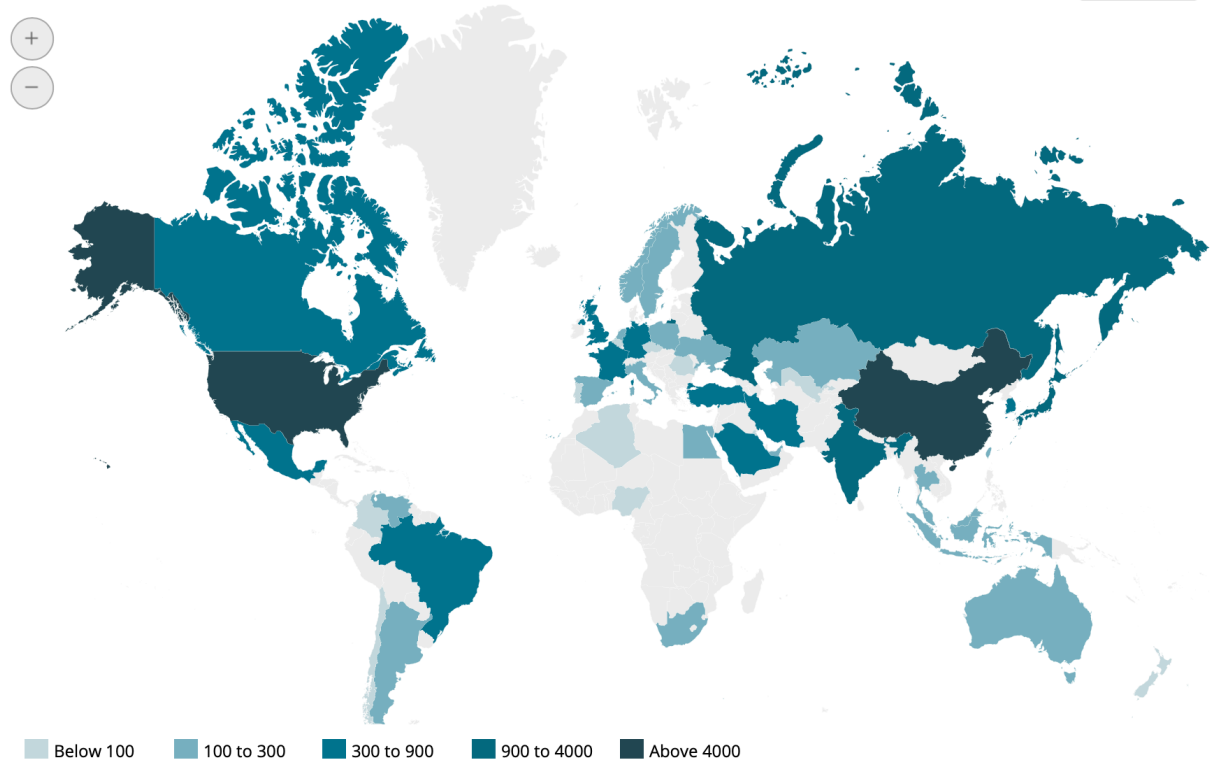
Top Electricity Producers in 2018 (TWh)



Unit: TWh

Highest

China	7,092
United States	4,429
India	1,643
Russia	1,128
Japan	1,102
Canada	663
Germany	647
Brazil	596
South Korea	593
France	571
Saudi Arabia	351
United Kingdom	334

Source: Enerdata Global Energy Statistical Yearbook 2019
https://yearbook.enerdata.net/electricity/world-electricity-production-statistics.html

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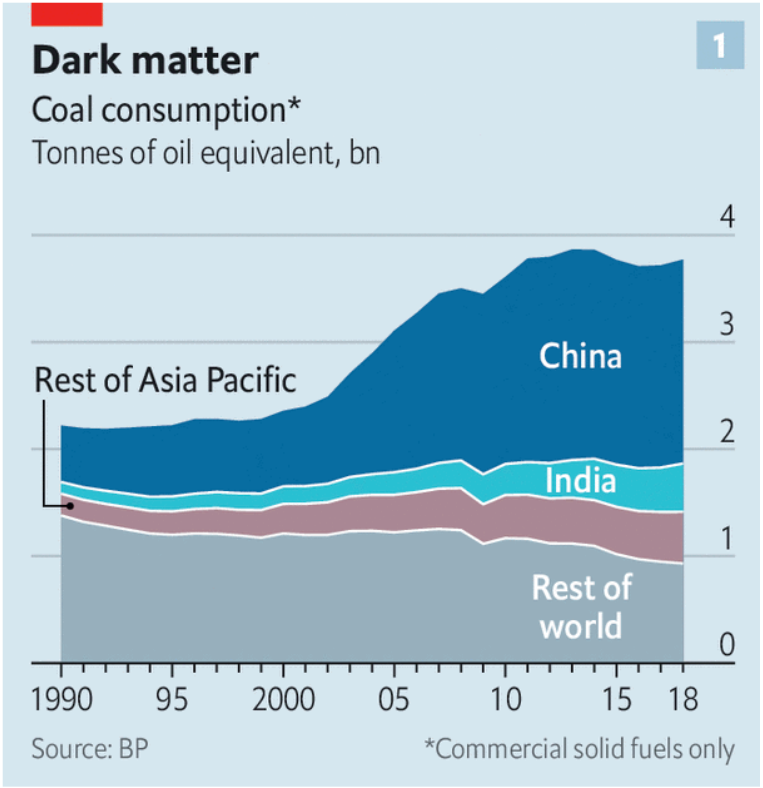
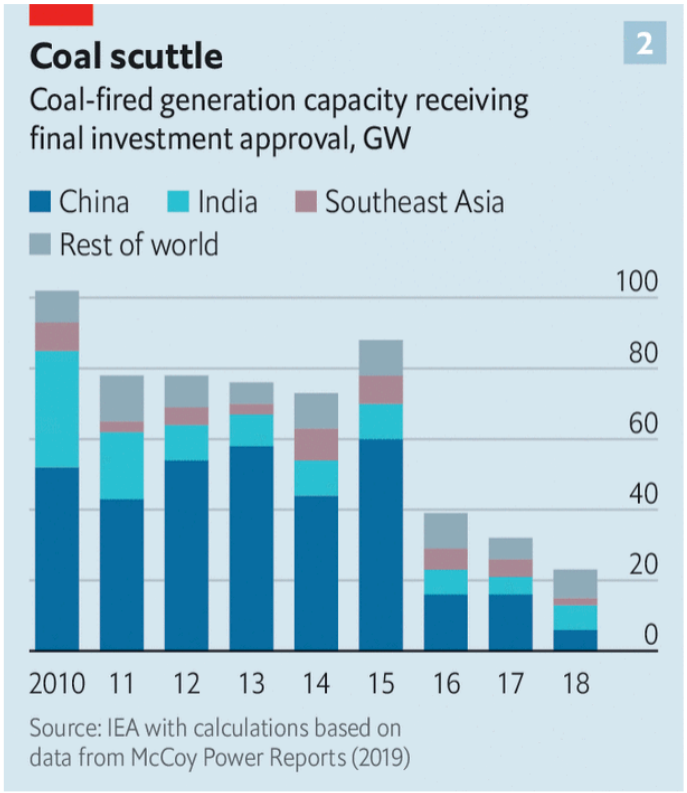
Over 75% of Global Demand for Coal Comes from Asia



The Economist



The Economist

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Top 20 Countries that emitted the most CO2 in 2016

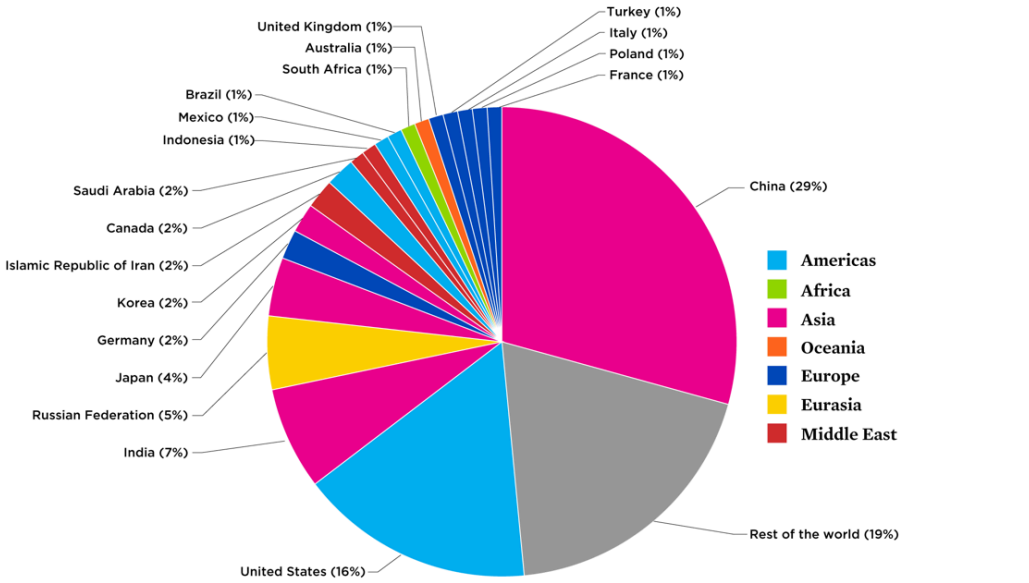
Rank	Country	CO_2 emissions (total)
1	China	9056.8MT
2	United States	4833.1MT
3	India	2076.8MT
4	Russian Federation	1438.6MT
5	Japan	1147.1MT
6	Germany	731.6MT
7	South Korea	589.2MT
8	Islamic Republic of Iran	563.4MT
9	Canada	540.8MT
10	Saudi Arabia	527.2MT
11	Indonesia	454.9MT
12	Mexico	445.5MT
13	Brazil	416.7MT
14	South Africa	414.4MT
15	Australia	392.4MT
16	United Kingdom	371.1MT
17	Turkey	338.8MT
18	Italy	325.7MT
19	Poland	293.1MT
20	France	292.9MT

REPORTS & MULTIMEDIA / EXPLAINER

Each Country's Share of CO2 Emissions

Published Jul 16, 2008 | Updated Oct 10, 2019

More:
En español



Source: Union of Concerened Scientists https://www.ucsusa.org/resources/each-countrys-share-co2-emissions

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Ranking by per capita CO2 emissions 2016

Rank	Country	CO_2 emissions (per capita)
1	Saudi Arabia	16.3T
2	Australia	16.2T
3	United States	15.0T
4	Canada	14.9T
5	South Korea	11.6T
6	Russian Federation	9.9T
7	Japan	9.0T
8	Germany	8.9T
9	Poland	7.7T
10	South Africa	7.4T
11	Islamic Republic of Iran	7.1T
12	China	6.4T
13	United Kingdom	5.6T
14	Italy	5.4T
15	France	4.5T
16	Turkey	4.2T
17	Mexico	3.6T
18	Brazil	2.0T
19	Indonesia	1.7T
20	India	1.6T

Source: Union of Concerened Scientists https://www.ucsusa.org/resources/each-countrys-share-co2-emissions

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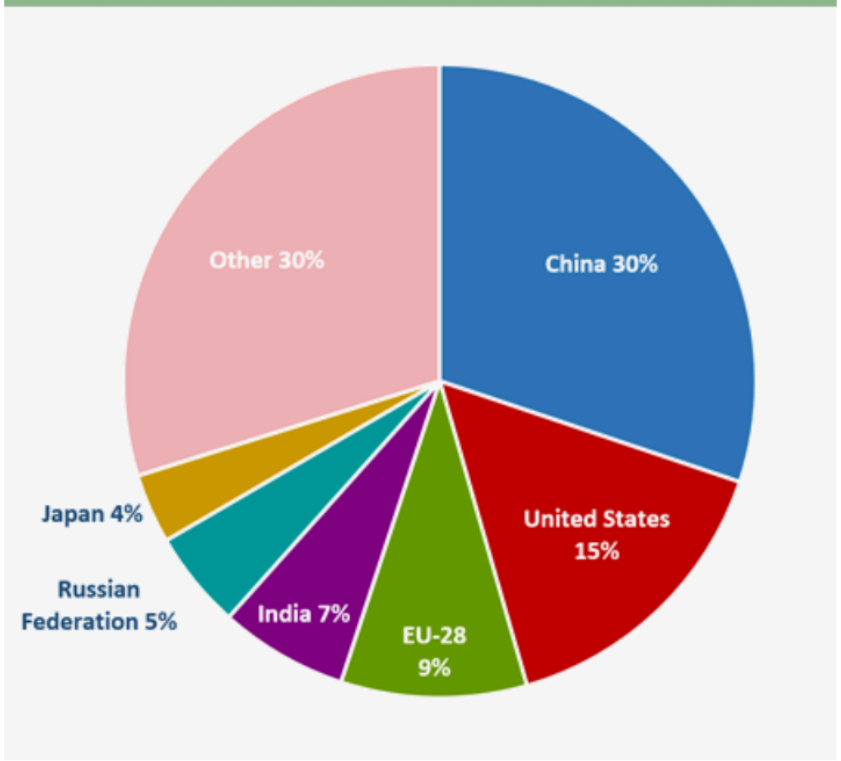
2014 Global CO_2 Emissions from Fossil Fuel Combustion and Some Industrial Processes



Source: Boden, T.A., Marland, G., and Andres, R.J. (2017). National CO2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2014, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, doi 10.3334/CDIAC/00001_V2017.

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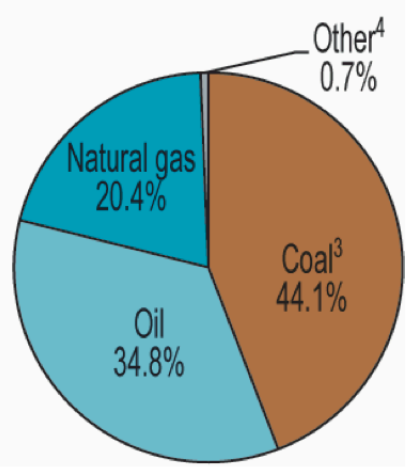
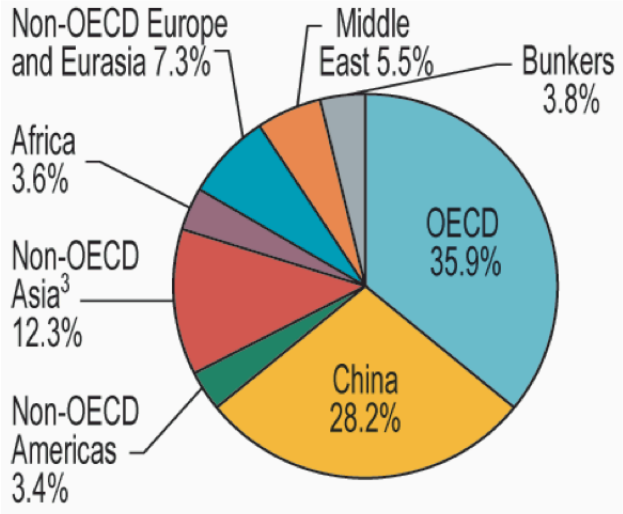
Global CO_2 Emissions from Fuel Combustion by Fuel Type - 2016



32 316 Mt of CO_2

Global CO_2 Emissions from Fuel Combustion By Region - 2016



32 316 Mt of CO_2

Source: IEA Key World Energy Statistics 2018

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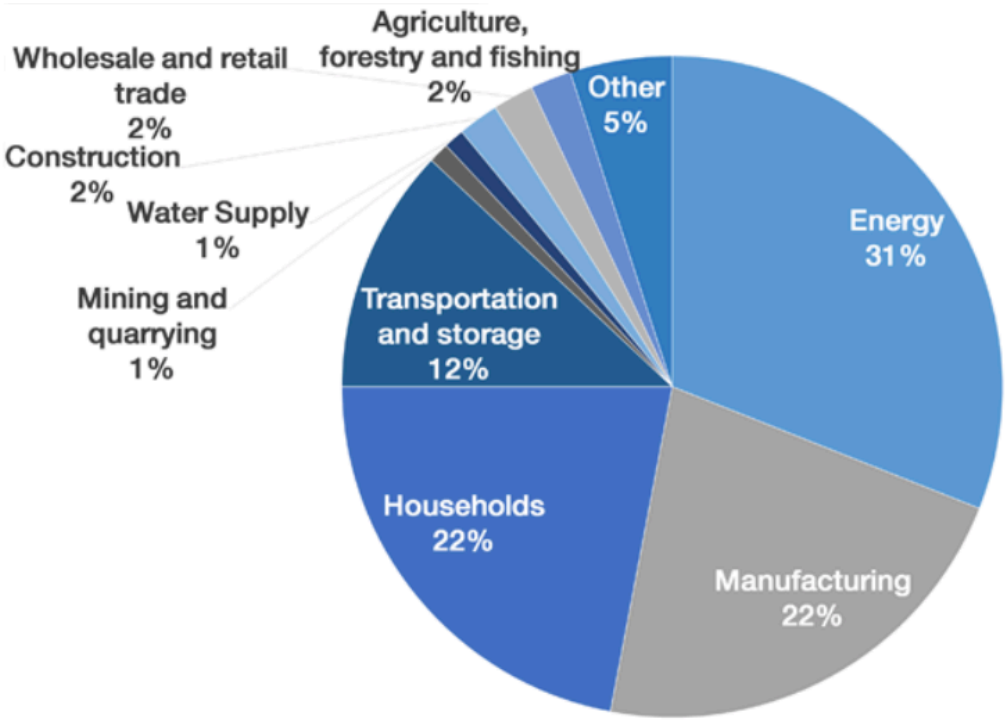
Sources of CO2 Emissions in Europe 2015



Source: OECD Environmental Statistics

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Changes in Generation Mix in China

Year	Hydro/Solar/Wind (%)	Thermal (%)
2001	25.56	73.47
2016	33.80	63.77
2018	37.00	60.00
2030	52.00	42.00

China will start to reduce its CO2 emissions beginning in 2030

Anthropogenic Carbon Emissions (2000)

- Electric Power Plants (33%)
- Transportation (33%)
- Direct Industrial Use (20%)
- Residential & Commercial Use (12%)

Six Greenhouse Gases

Carbon dioxide (CO_2)

Methane (CH_4)

Nitrous oxide (N_2O)

Hydro fluorocarbons (HFCs)

Per fluorocarbons (PFCs)

Sulphur hexafluoride (SF_6)

1997 CO2 emissions from fossil fuels and cement production: 30.4 billion tons

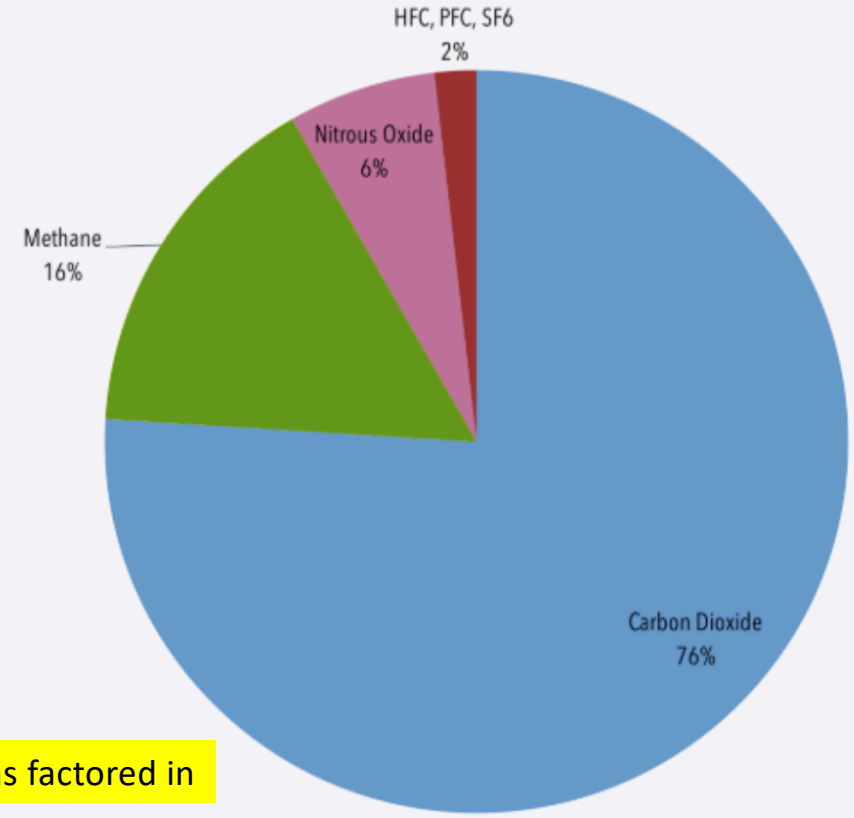
2018 CO2 emissions from fossil fuels and cement production: 41.1 billion tons

Global Warming Potential (GWP) of Greenhouse Gases

Carbon dioxide (CO_2):	1
Methane (CH_4):	28
Nitrous oxide (N_2O):	265
Hydro fluorocarbons (HFCs):	138
Per fluorocarbons (PFCs):	6,630
Sulphur hexafluoride (SF_6):	23,500

(over 100-year time scale)

Global Manmade Greenhouse Gas Emissions by Gas, 2015



Concentrations factored in

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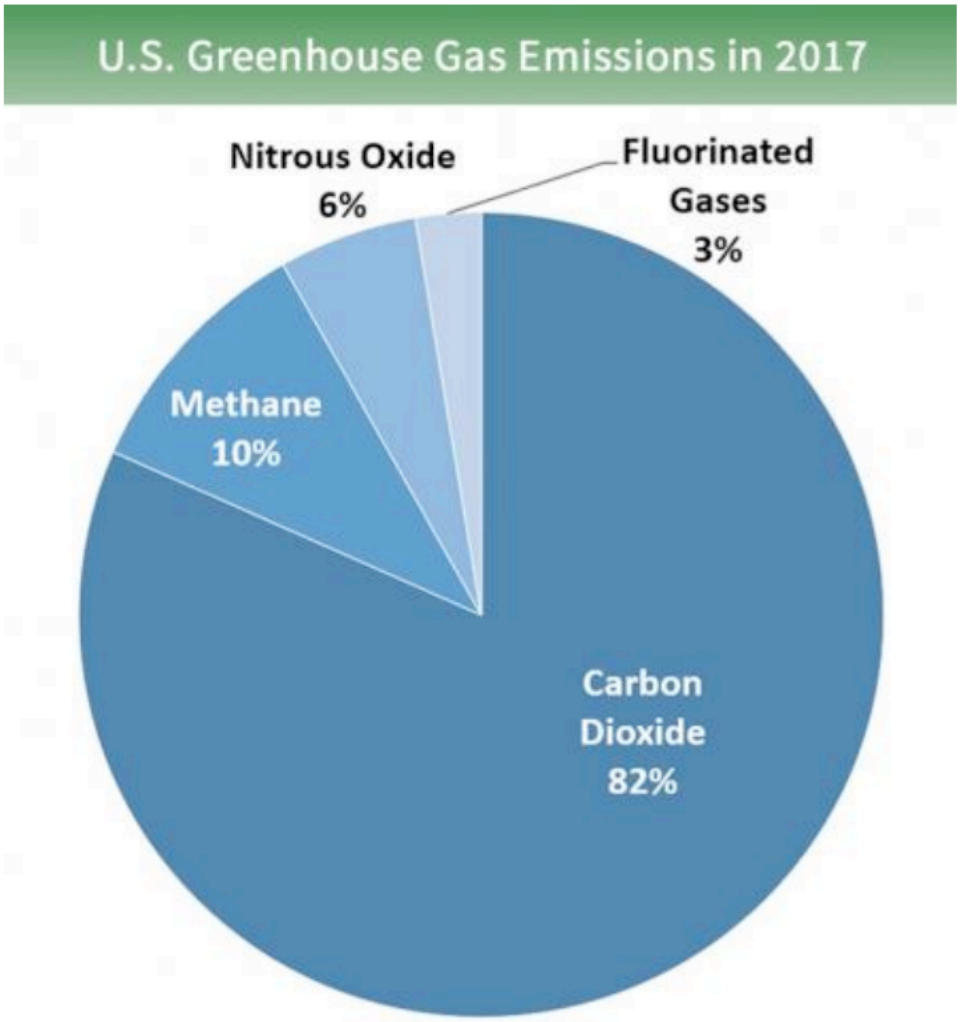

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Sources of atmospheric methane

(1) Natural wetlands;

(2) Paddy rice fields;

(3) Emission from livestock production systems;

(4) Biomass burning (including forest fires);

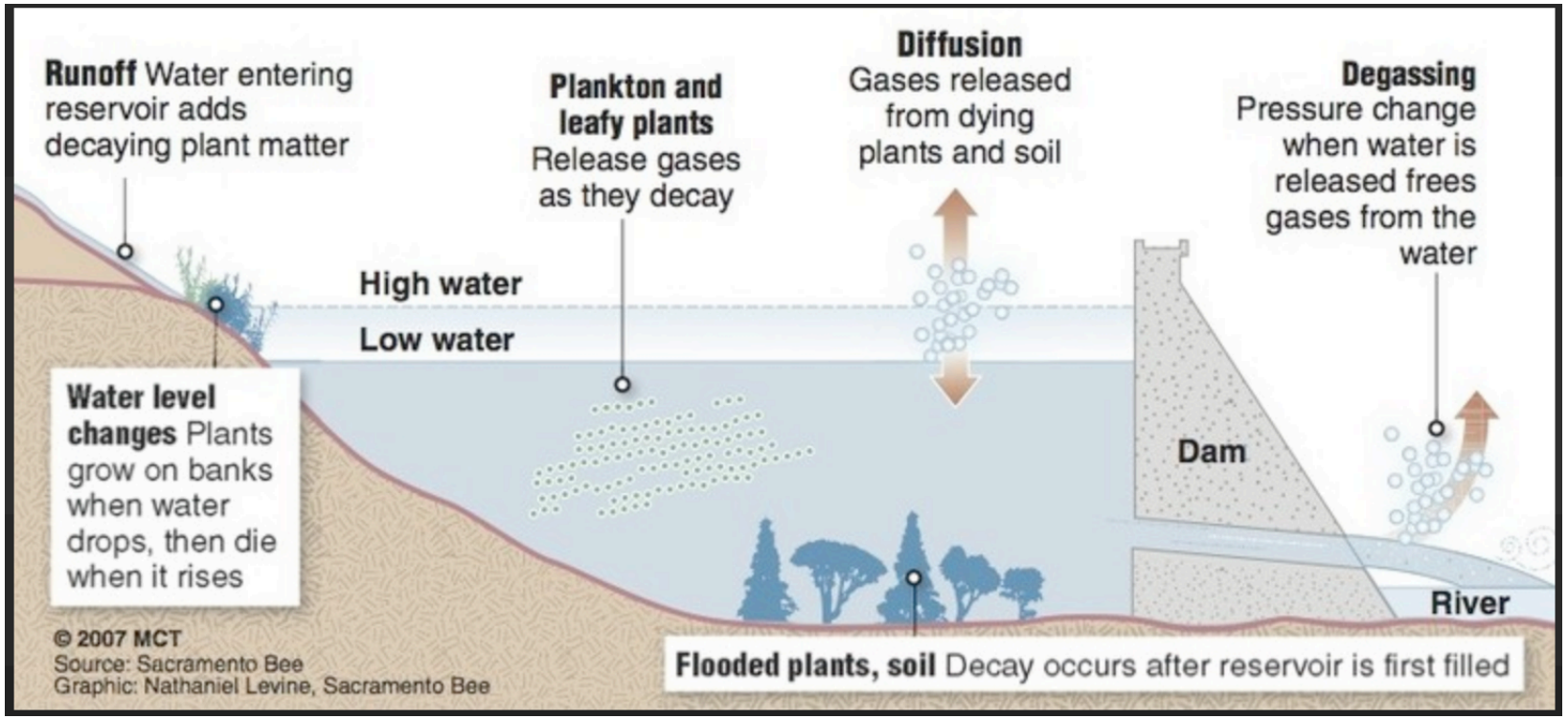
(5) Anaerobic decomposition of organic waste in landfills;

(6) Fossil methane emission during the exploration and transport of fossil fuels.

Emission Characteristics of Power Plants in the US (grams/kWhr)

Plant Type	NOx	SO_2	CO_2
Gas	2.32	0.004	490
Oil	2.02	5.08	781
Coal	3.54	9.26	1090

Greenhouse Gases from Hydroelectricity



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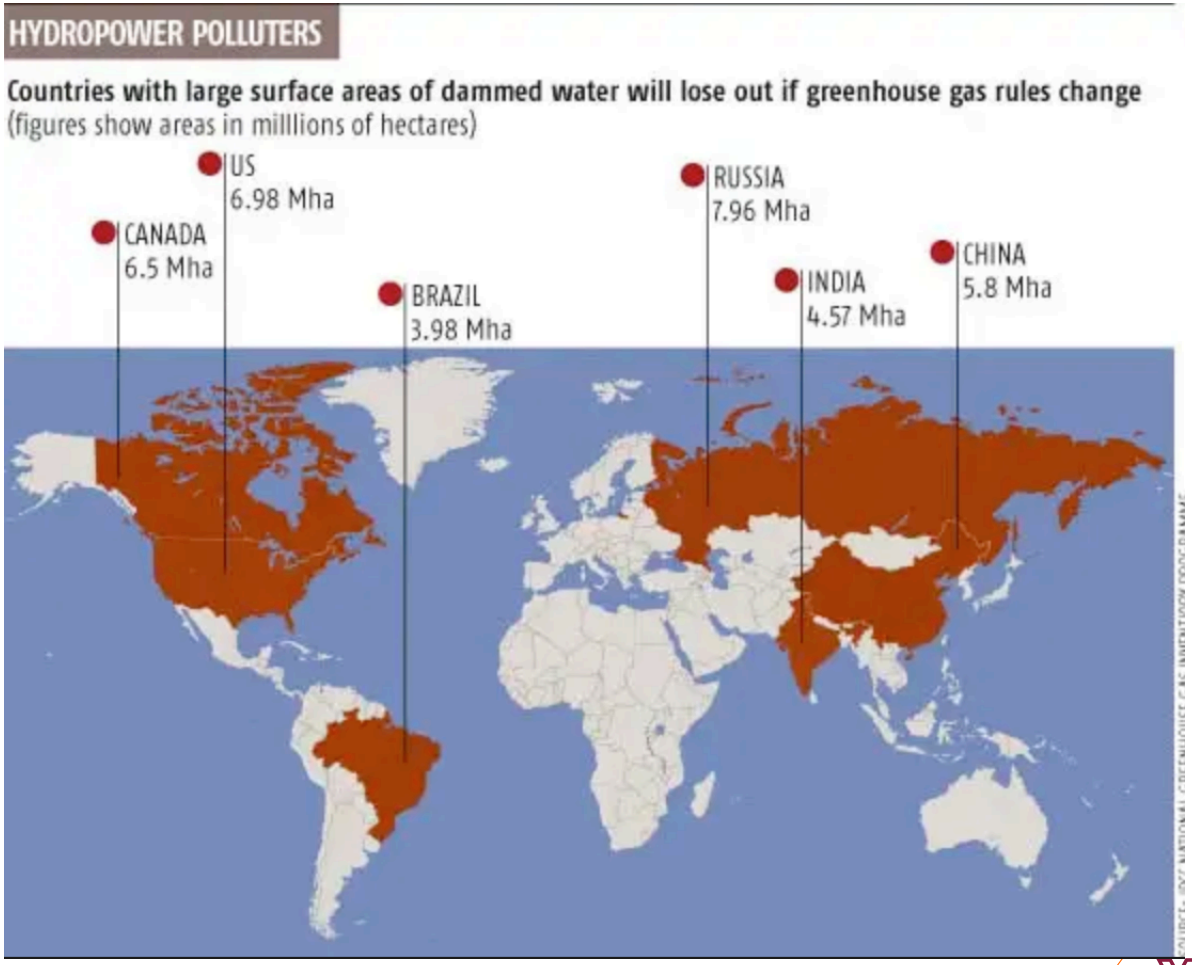

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Hydroelectricity is not Emission Free

One kWhr of coal-based electricity releases 1090 gm of CO_2

One kWhr of hydro-based electricity releases 225 gm of CO_2 equivalent

One litre of gasoline releases 3.00 kg of CO_2 from manufacture to consumption in a vehicle

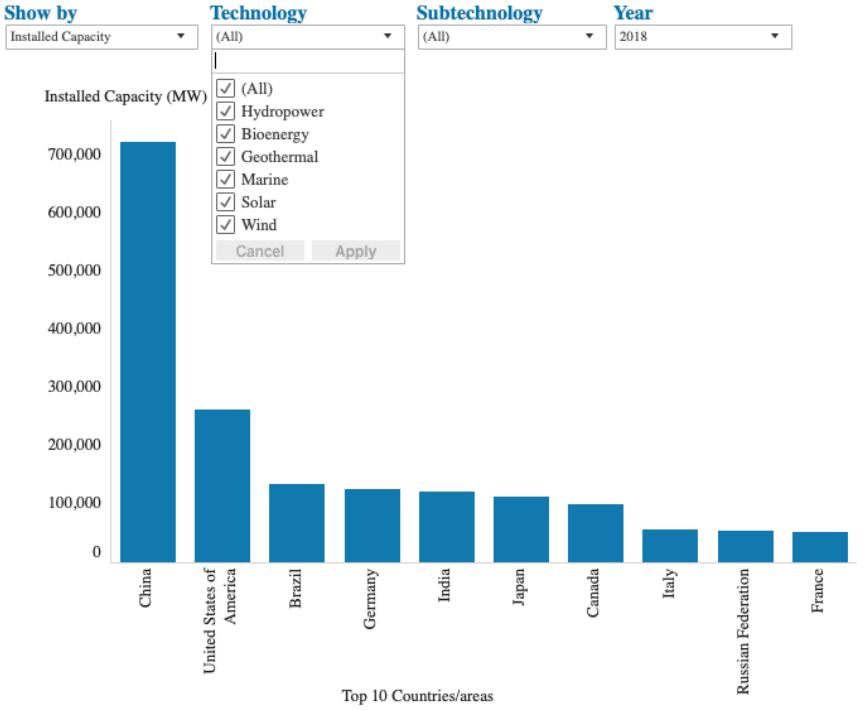
Reduce Carbon Emissions from Electricity Production

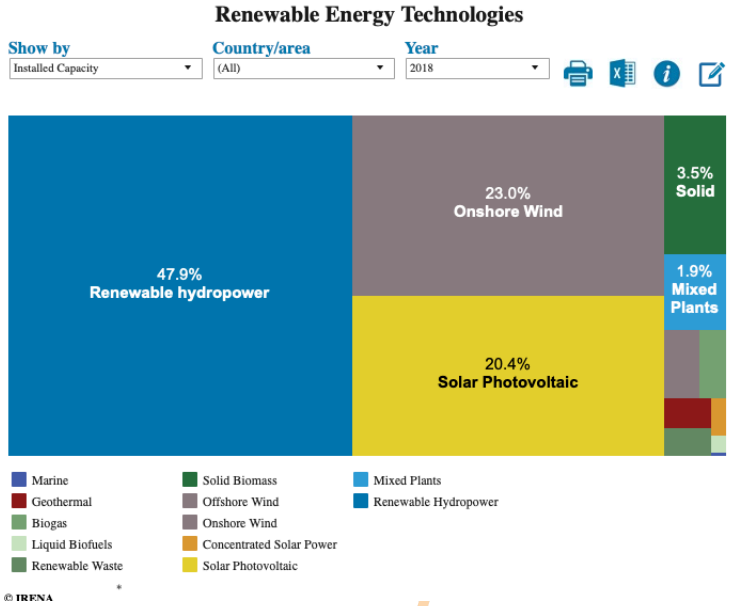
(1) Use less electricity

(2) Use less fuel to produce electricity

(3) Produce more electricity from renewables & nuclear

Top Ten Countries Total Installed Renewable Energy Capacity in 2018





Source: International Renewable Energy Agency IRENA https://www.irena.org/Statistics/

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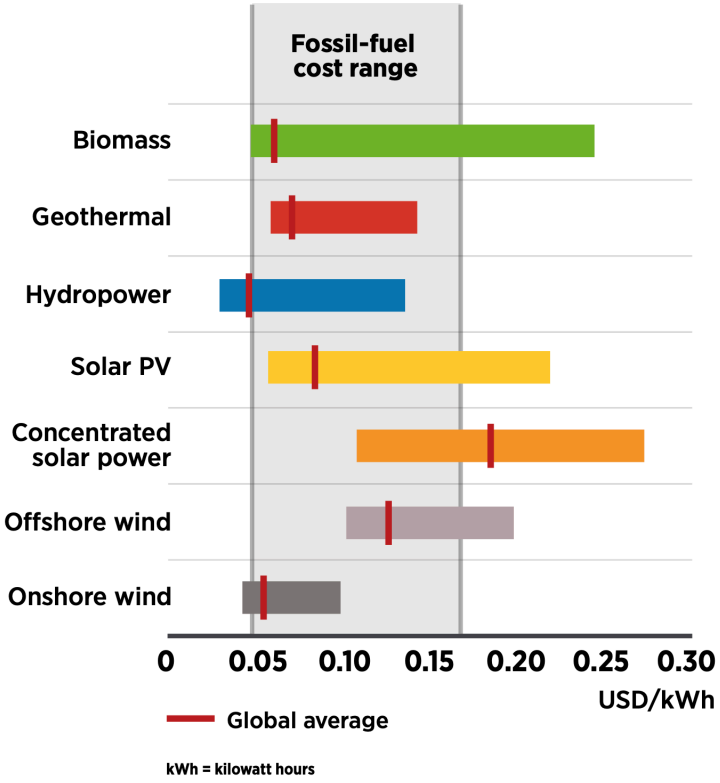
Renewable power generation has reached a competitive tipping point



» Renewable power generation costs in 2018

Source: People, Planet and Prosperity: Raising Climate Ambitions Through Renewables, IRENA 2019

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So, What is the bottom line?

- Efforts in the electric power sector by replacing fossil fuel with renewables and nuclear will help
- But if emission from the transportation sector continues to rise, the power sector contributions will not be enough
- Large scale Electric Vehicle deployment will help, but question remains – how will the EV be powered

I would like to see a broader IEEE

We need to ensure that we are “READY FOR RECOVERY”, when we get back to the “NEW NORMAL” after COVID-19. Let us enhance cooperation, collaboration and community spirit.

For this we need to make IEEE broader so that IEEE is more relevant to the work our members do regardless where they work.

We need more participation from volunteers globally in IEEE governance. A broader based IEEE will make the Institute more relevant to technologists and academics from all parts of the world.

I would like to see more IEEE Senior Members and IEEE Fellows from Regions 8, 9 & 10

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Past-Chair, IEEE Publication Services & Products Board

PES accomplishments:

- PES University
- PES Corporate Engagement Program
- PES Chapters' Councils in China, India, Africa and Latin America

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