

IEEE NZ North Section

**Lifelong Learning series
2020**

Global Electric Power Sector: Engaging with Environmental Issues

Professor Saifur Rahman

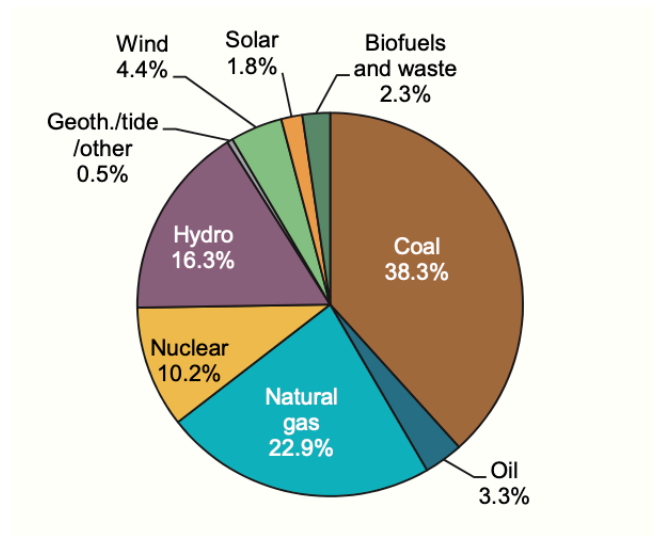
Director, Virginia Tech Advanced Research Inst., USA
President, IEEE Power & Energy Society, 2018 & 2019



New Zealand North Chapter

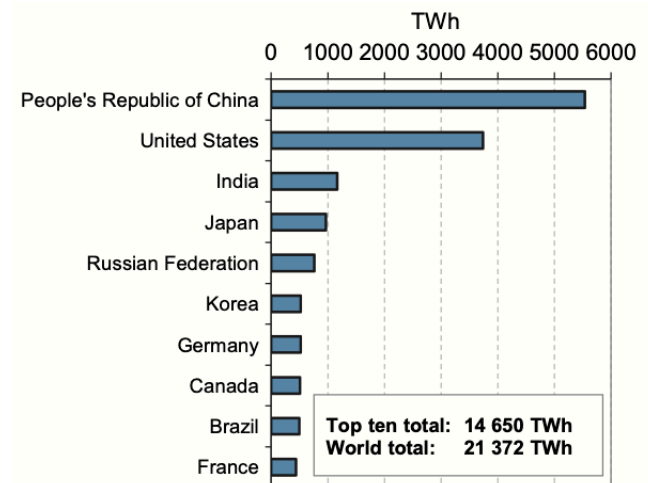
IEEE
Student Branch
University of Auckland &
Auckland University of Technology

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



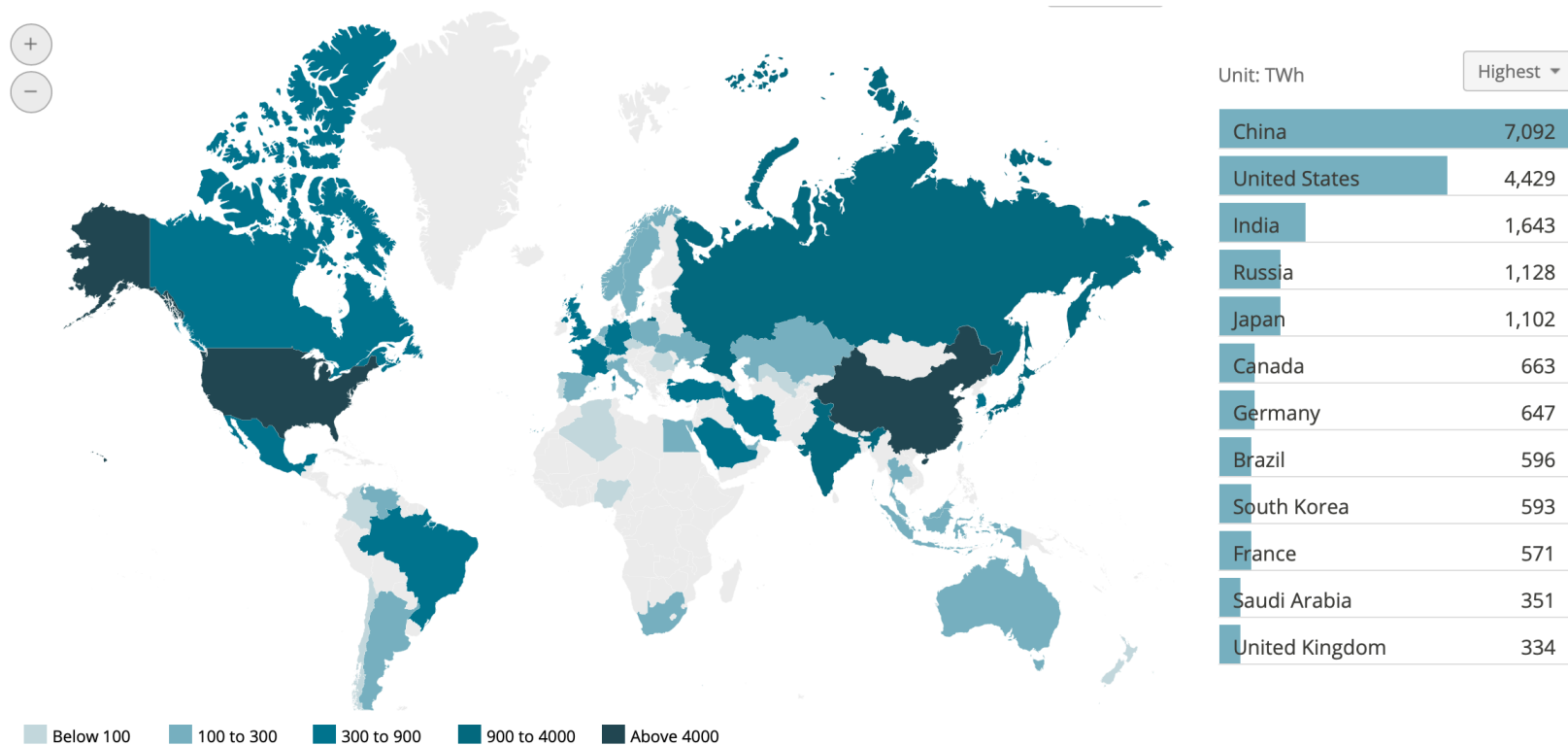
Source: IEA Electricity
Information Overview 2019

Top 10 Electricity Consuming Countries in 2017 TWh



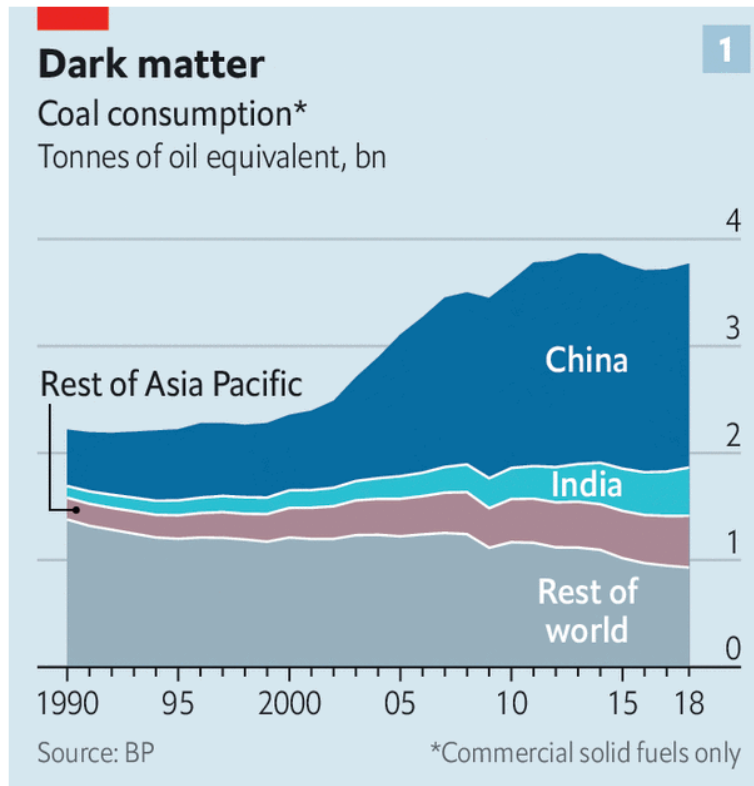
Source: IEA Electricity Information Overview 2019

Top Electricity Producers in 2018 (TWh)

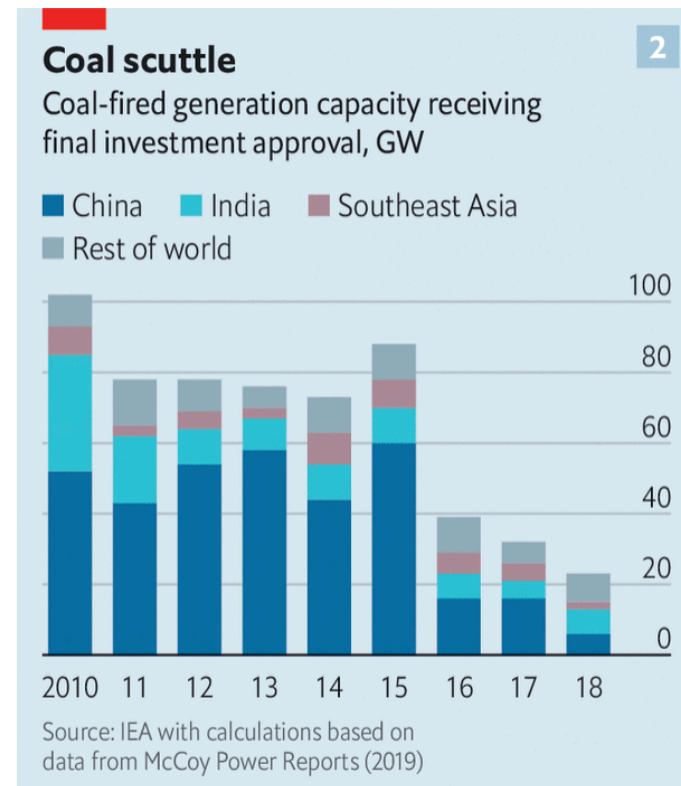


Source: Enerdata Global Energy Statistical Yearbook 2019
<https://yearbook.enerdata.net/electricity/world-electricity-production-statistics.html>

Over 75% of Global Demand for Coal Comes from Asia



The Economist



The Economist

Top 20 Countries that emitted the most CO2 in 2016

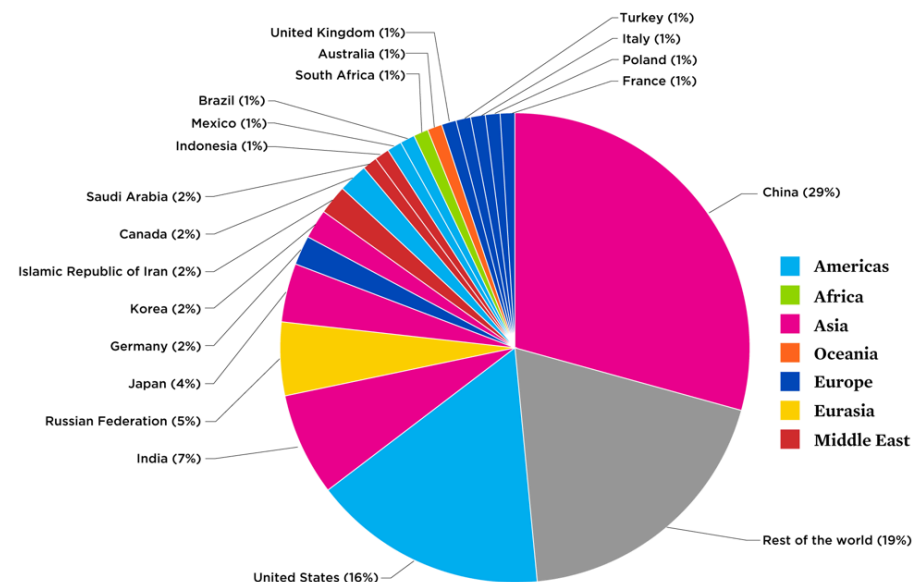
Rank	Country	CO ₂ emissions (total)
1	China	9056.8MT
2	United States	4833.1MT
3	India	2076.8MT
4	Russian Federation	1438.6MT
5	Japan	1147.1MT
6	Germany	731.6MT
7	South Korea	589.2MT
8	Islamic Republic of Iran	563.4MT
9	Canada	540.8MT
10	Saudi Arabia	527.2MT
11	Indonesia	454.9MT
12	Mexico	445.5MT
13	Brazil	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](#)



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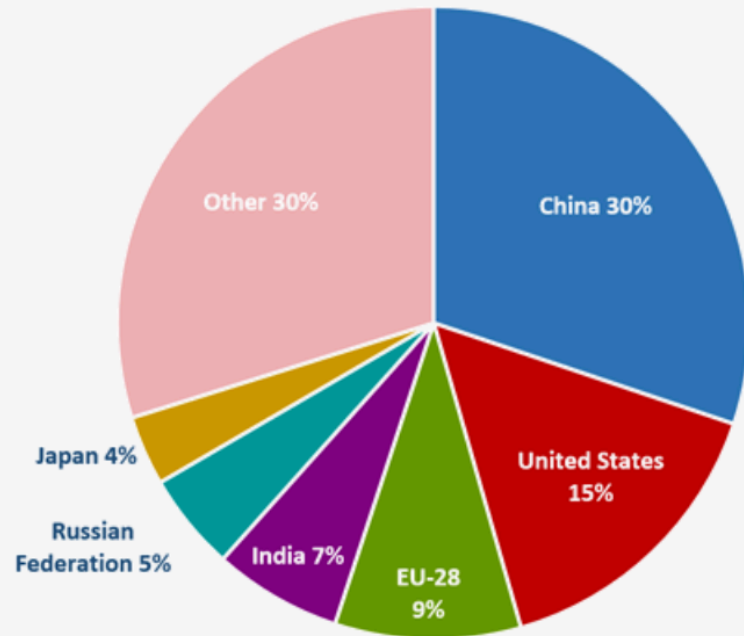
Source: Union of Concerned Scientists <https://www.ucsusa.org/resources/each-country-share-co2-emissions>

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

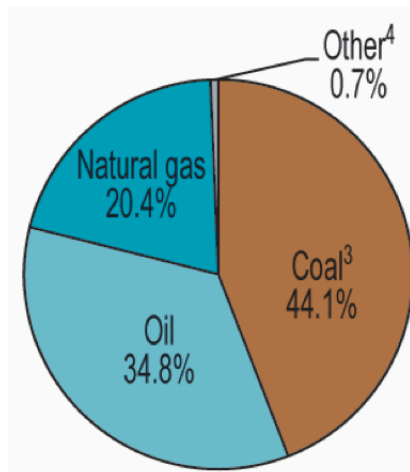
Source: Union of Concerned Scientists <https://www.ucsusa.org/resources/each-country-share-co2-emissions>

2014 Global CO₂ Emissions from Fossil Fuel Combustion and Some Industrial Processes



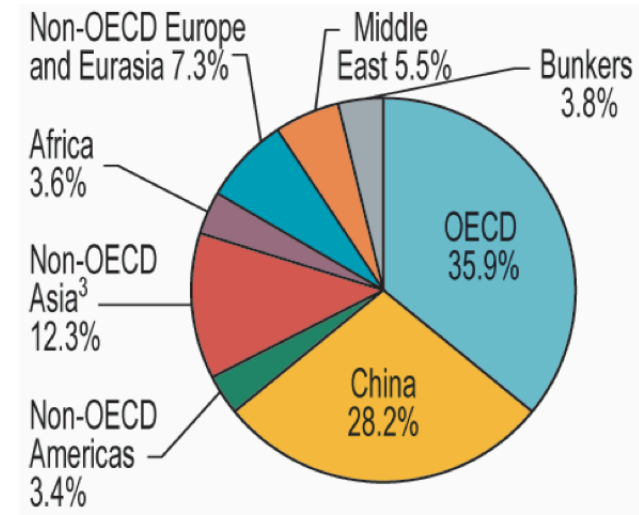
Source: Boden, T.A., Marland, G., and Andres, R.J. (2017). [National CO₂ Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2014](#), Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, doi 10.3334/CDIAC/00001_V2017.

Global CO₂ Emissions from Fuel Combustion
by Fuel Type - 2016



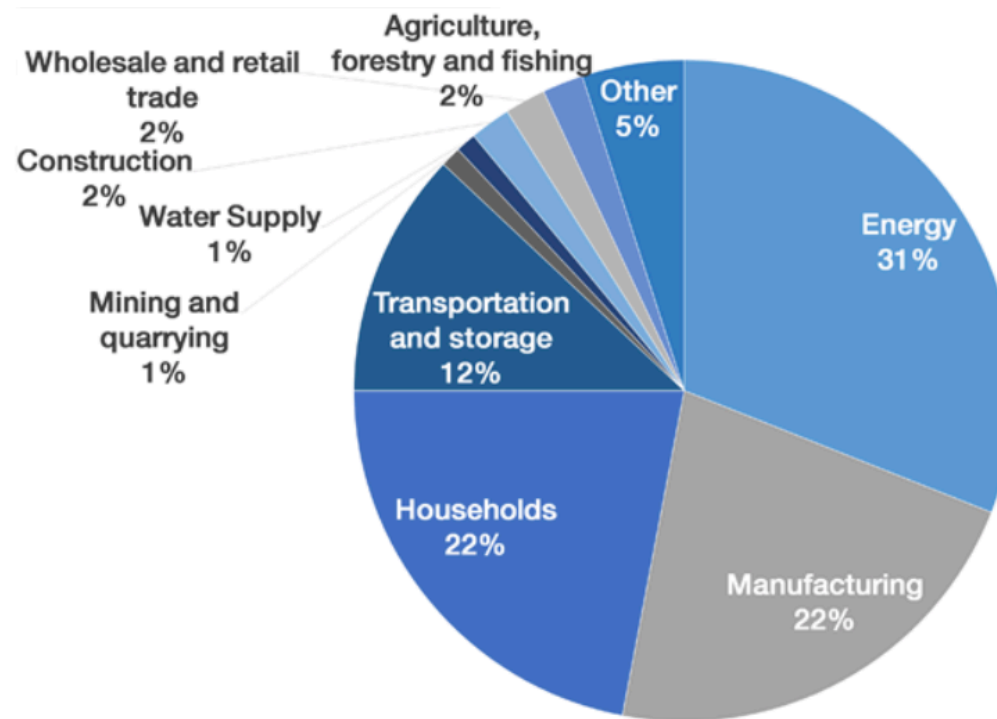
32 316 Mt of CO₂

Global CO₂ Emissions from Fuel Combustion
By Region - 2016



32 316 Mt of CO₂

Sources of CO₂ Emissions in Europe 2015



Source: OECD Environmental Statistics

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 (CO₂)

Methane (CH₄)

Nitrous oxide (N₂O)

Hydro fluorocarbons (HFCs)

Per fluorocarbons (PFCs)

Sulphur hexafluoride (SF₆)

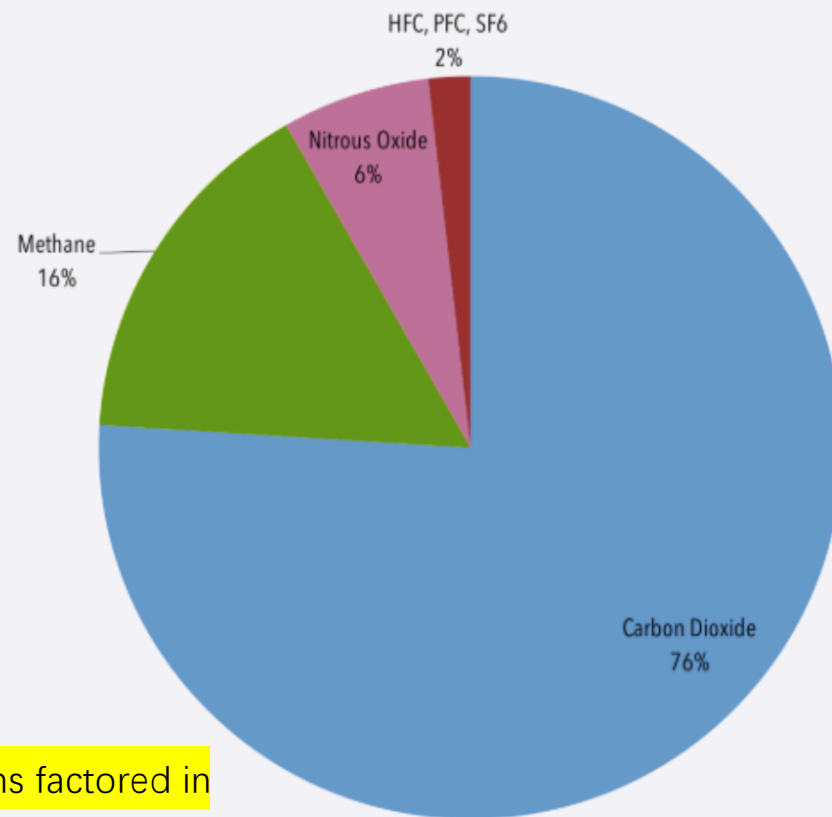
1997 CO₂ emissions from fossil fuels and cement production: 30.4 billion tons

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

Global Warming Potential (GWP) of Greenhouse Gases

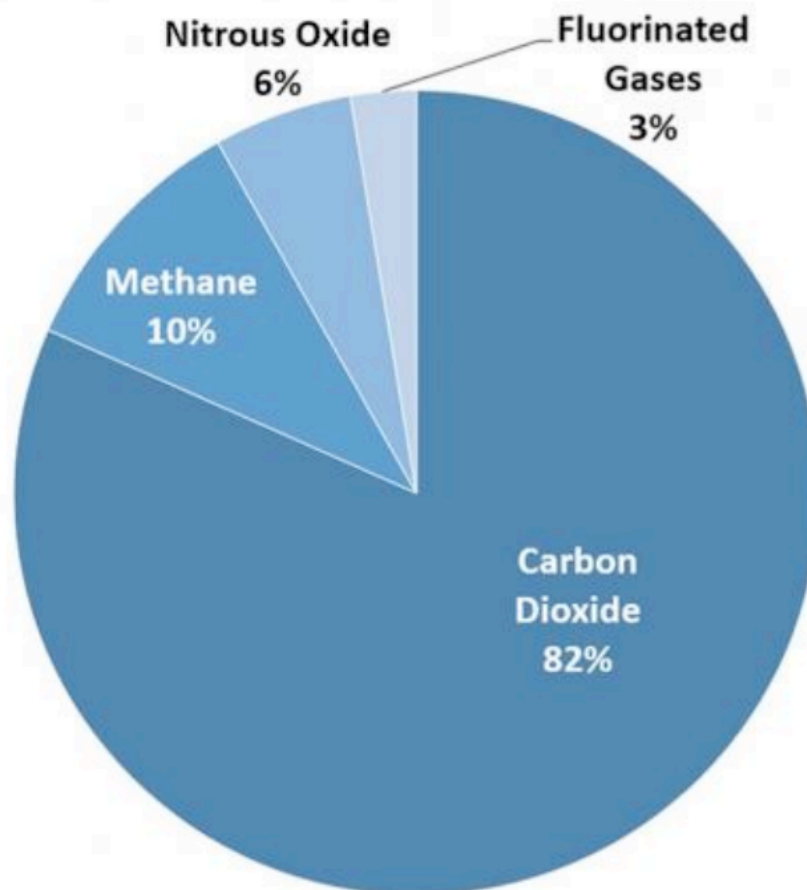
Carbon dioxide (CO ₂):	1
Methane (CH ₄):	28
Nitrous oxide (N ₂ O):	265
Hydro fluorocarbons (HFCs):	138
Per fluorocarbons (PFCs):	6,630
Sulphur hexafluoride (SF ₆):	23,500
<i>(over 100-year time scale)</i>	

Global Manmade Greenhouse Gas Emissions by Gas, 2015



Concentrations factored in

U.S. Greenhouse Gas Emissions in 2017



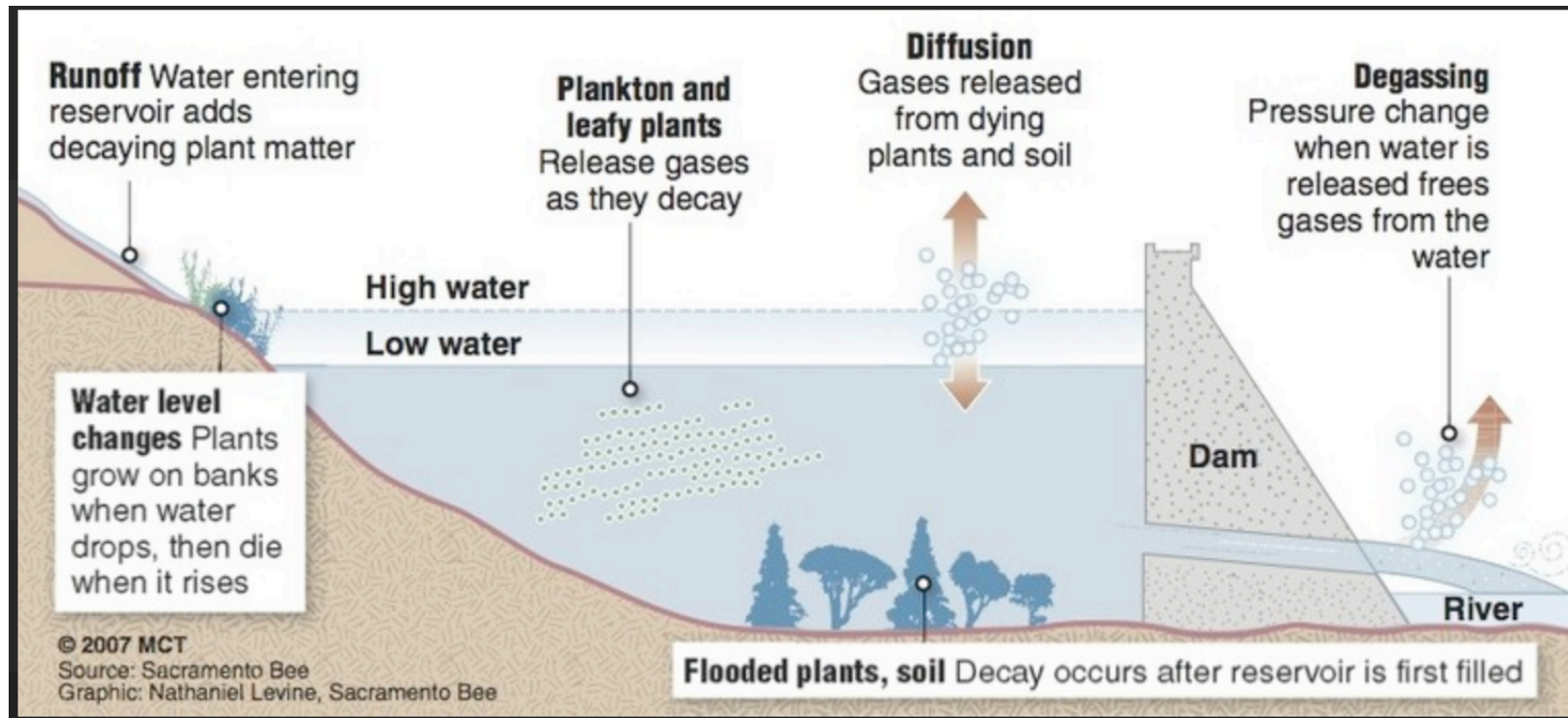
Sources of atmospheric methane

- (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/kW hr)

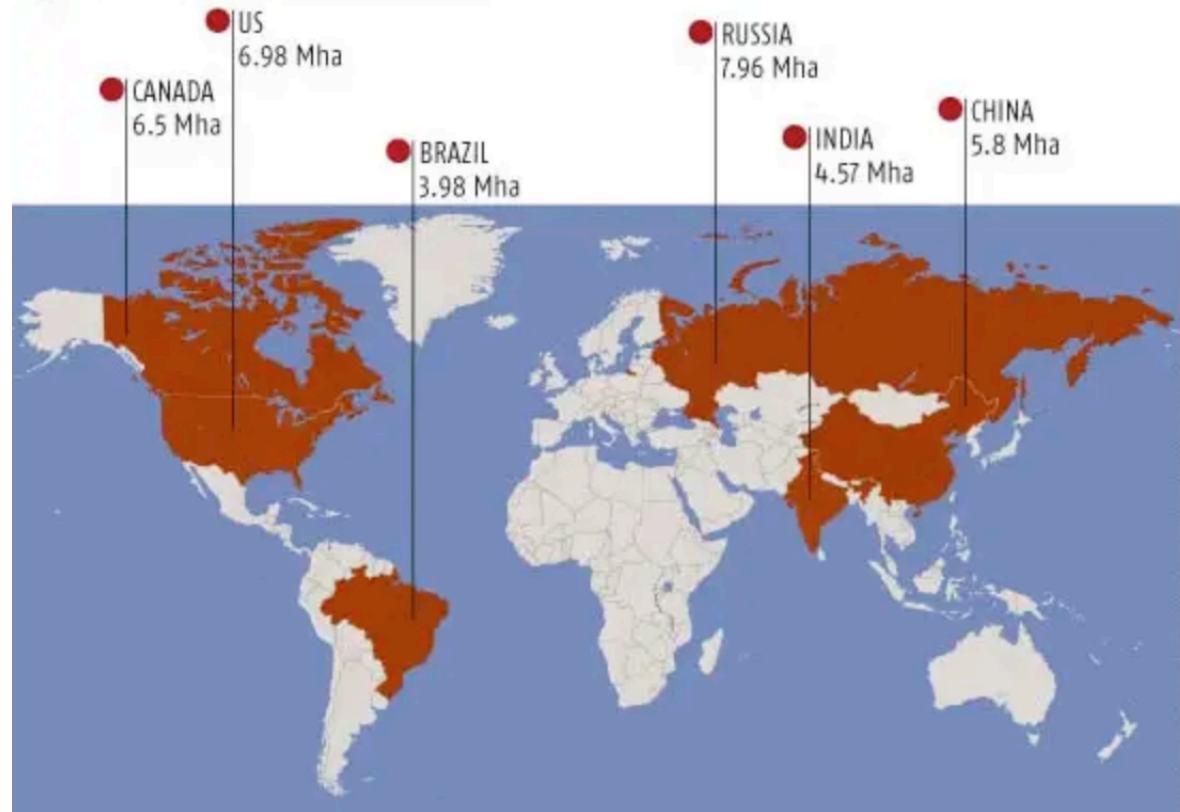
Plant Type	NO _x	SO ₂	CO ₂
Gas	2.32	0.004	490
Oil	2.02	5.08	781
Coal	3.54	9.26	1090

Greenhouse Gases from Hydroelectricity



HYDROPOWER POLLUTERS

Countries with large surface areas of dammed water will lose out if greenhouse gas rules change
(figures show areas in millions of hectares)



Hydroelectricity is not Emission Free

One kWhr of **coal-based** electricity releases **1090 gm of CO₂**

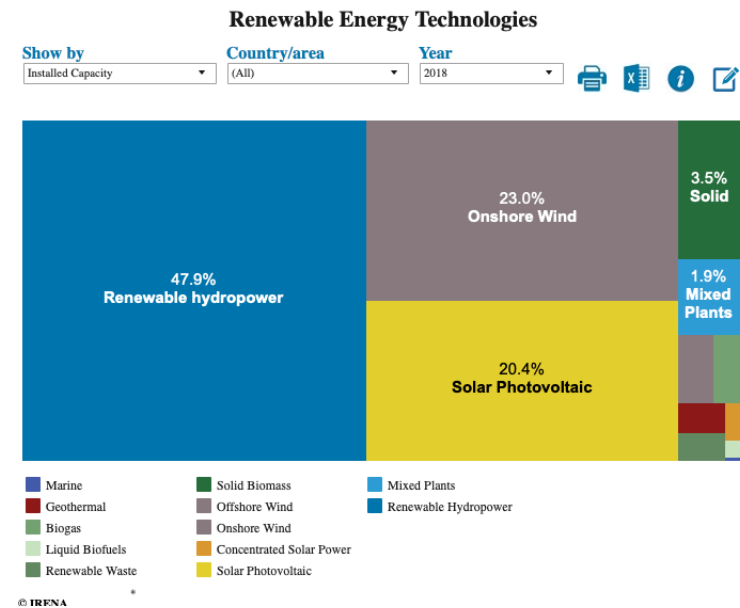
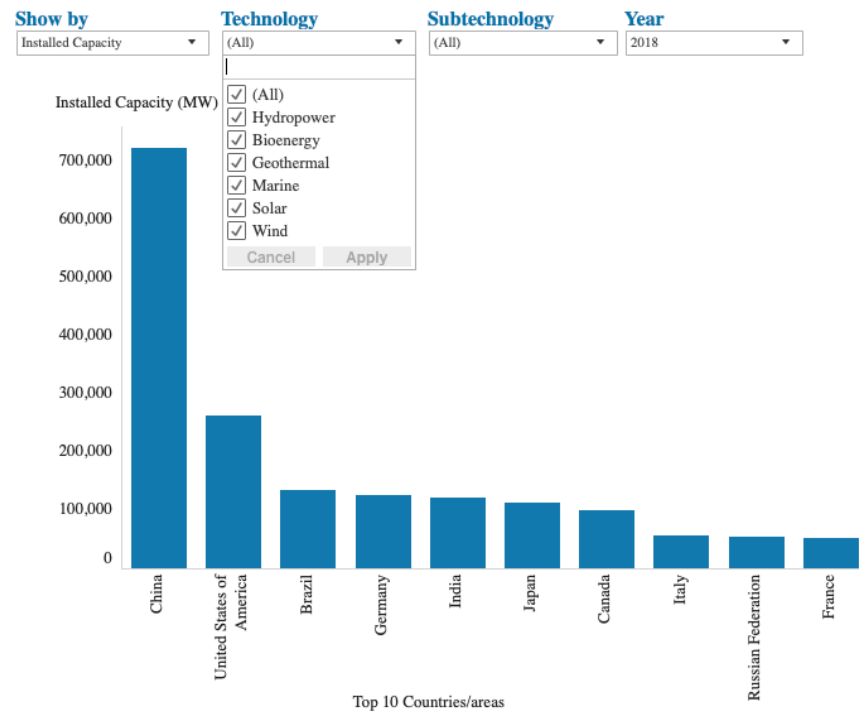
One kWhr of **hydro-based** electricity releases **225 gm of CO₂**
equivalent

One litre of **gasoline** releases **3.00 kg of CO₂** from manufacture to
consumption in a vehicle

Reduce Carbon Emissions from Electricity Production

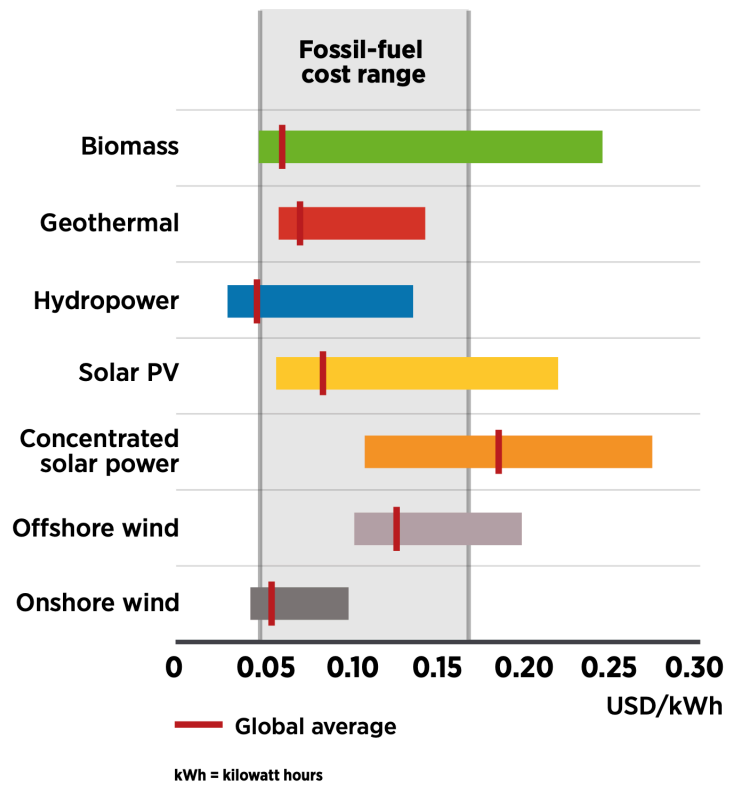
- (1) Use less electricity
- (2) Use less fuel to produce electricity
- (3) Produce more electricity from renewables & nuclear

Top Ten Countries Total Installed Renewable Energy Capacity in 2018



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

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

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



Covid-19 and IEEE

The COVID-19 outbreak is incredibly fast moving, uncertain and complex.

We need to ensure that we are “READY FOR RECOVERY” , when we get back to the “NEW NORMAL” . 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.

Prof. Saifur Rahman (s.rahman@ieee.org)



Past-President of IEEE Power & Energy Society
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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