

# Global Electric Power Sector: Engaging with Environmental Issues

AUPEC Conf., Univ of Tasmania, Australia, 01 December 2020

**KEYNOTE SPEECH**

**Professor Saifur Rahman**

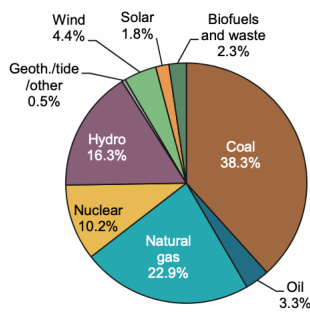
DIRECTOR, VIRGINIA TECH ADVANCED RESEARCH INST., USA

PRESIDENT, IEEE POWER & ENERGY SOCIETY, 2018 & 2019



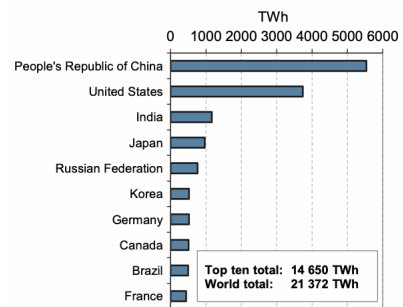
1

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



Source: IEA Electricity Information Overview 2019

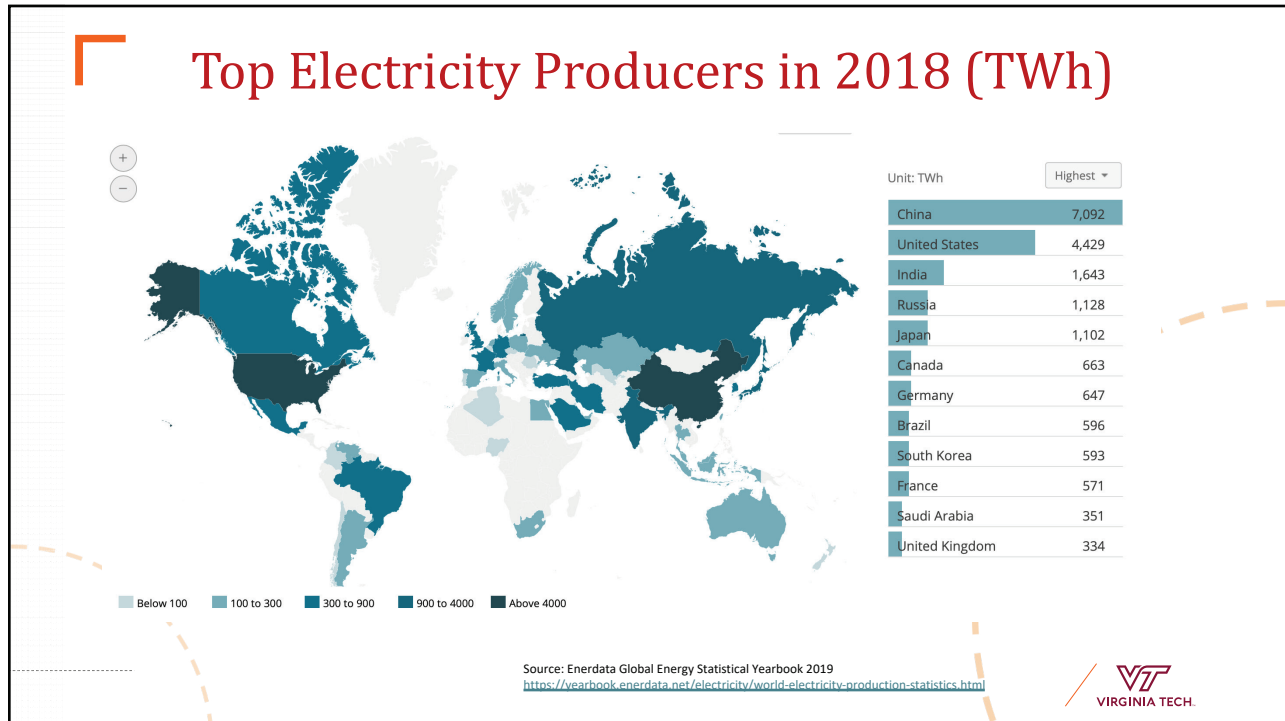
**Top 10 Electricity Consuming Countries in 2017  
TWh**



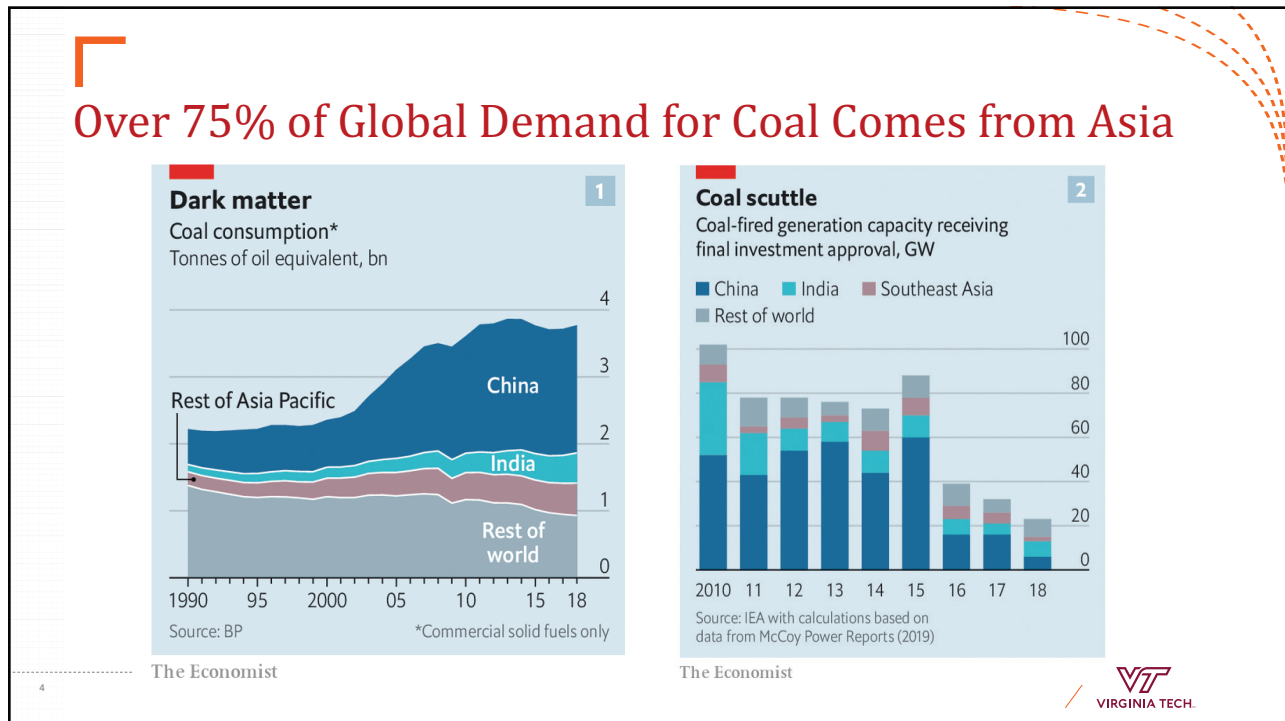
Source: IEA Electricity Information Overview 2019



2



3



4

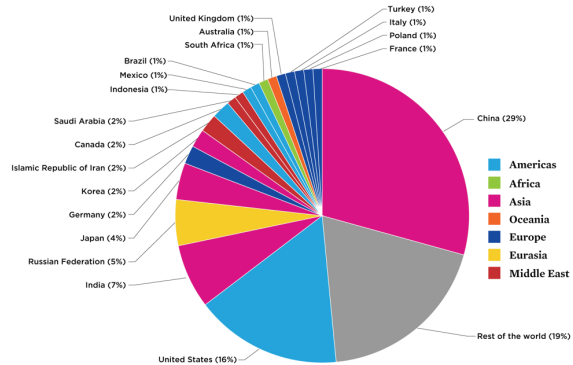
Top 20 Countries that emitted the most CO2 in 2016

Rank	Country	CO2 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 Concerned Scientists <https://www.ucsusa.org/resources/each-countrys-share-co2-emissions>



5

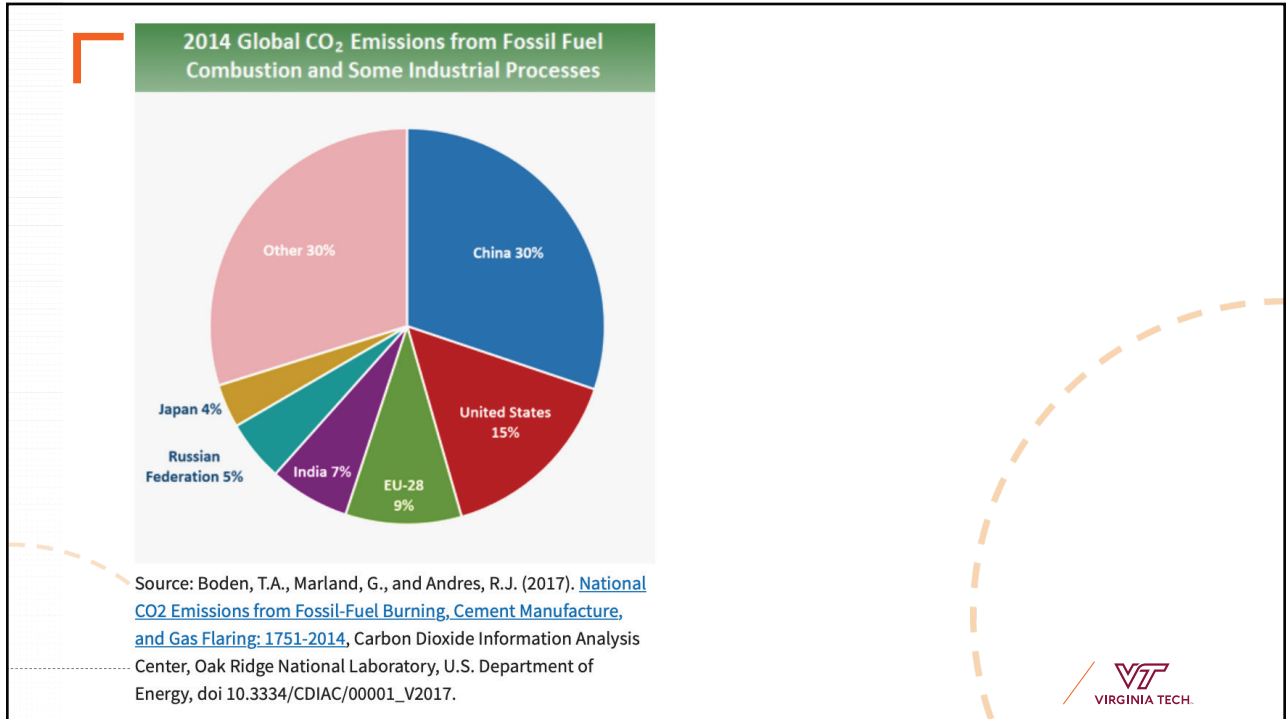
Ranking by per capita CO2 emissions 2016

Rank	Country	CO2 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

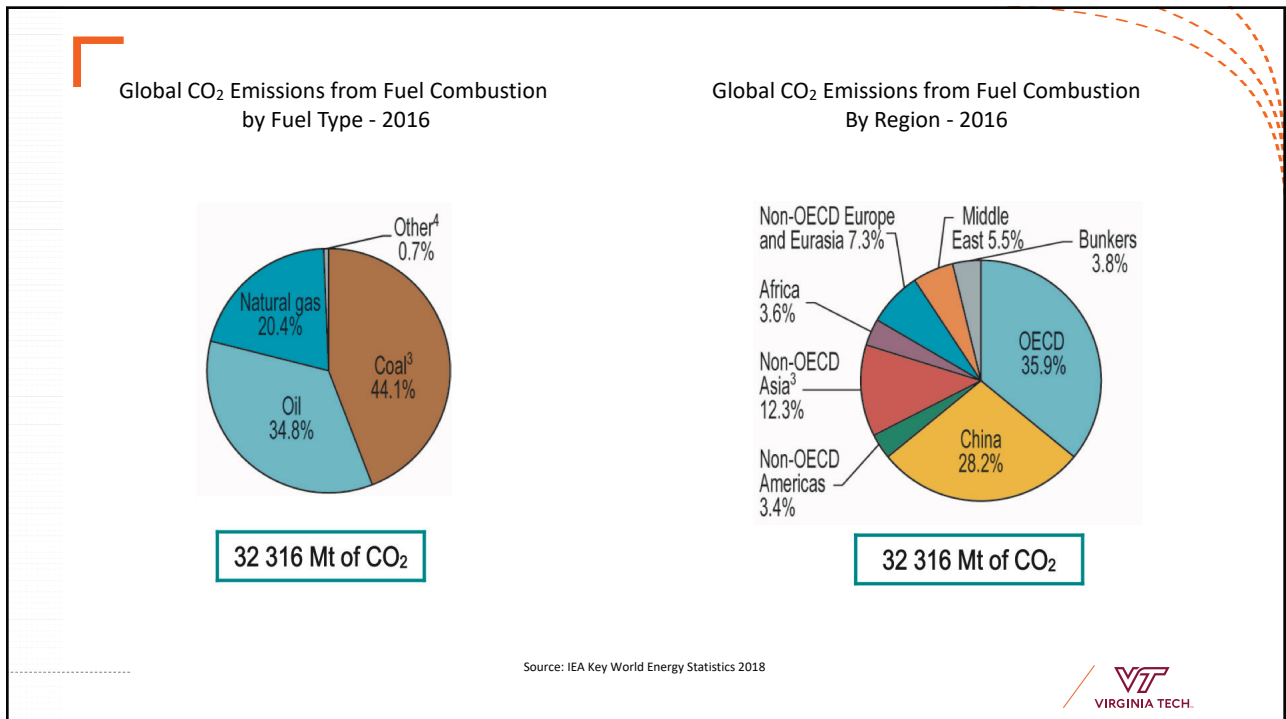
Source: Union of Concerned Scientists <https://www.ucsusa.org/resources/each-countrys-share-co2-emissions>



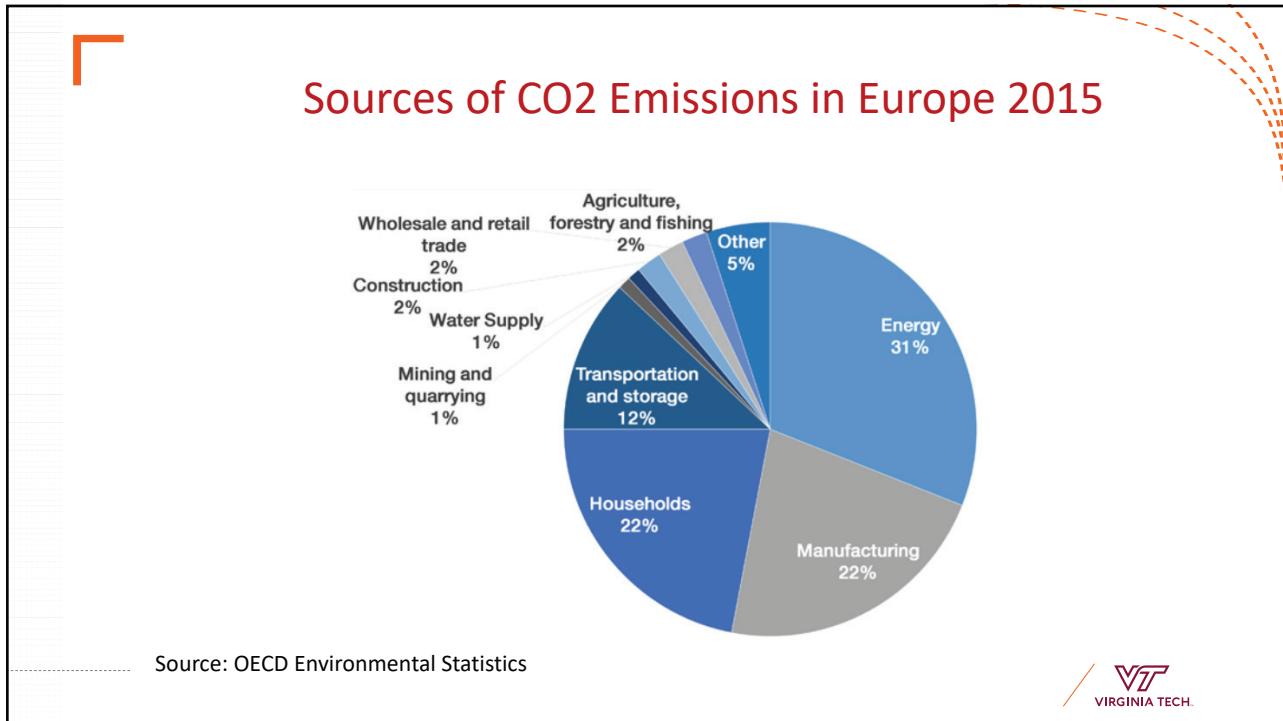
6



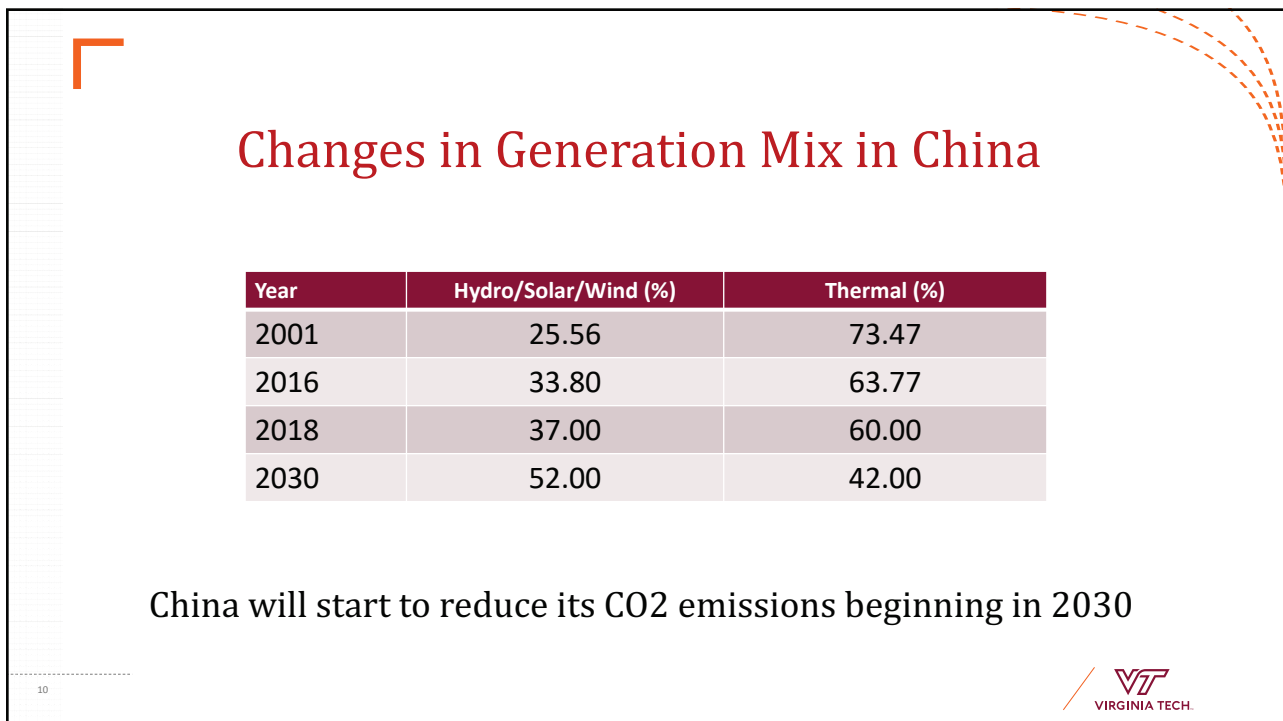
7



8



9



10

## Anthropogenic Carbon Emissions (2000)

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

11



11

## Six Greenhouse Gases

Carbon dioxide (CO<sub>2</sub>)

Methane (CH<sub>4</sub>)

Nitrous oxide (N<sub>2</sub>O)

Hydro fluorocarbons (HFCs)

Per fluorocarbons (PFCs)

Sulphur hexafluoride (SF<sub>6</sub>)

1997 CO<sub>2</sub> emissions from fossil fuels and cement production: 30.4 billion tons

2018 CO<sub>2</sub> emissions from fossil fuels and cement production: 41.1 billion tons

12



12

## Global Warming Potential (GWP) of Greenhouse Gases

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

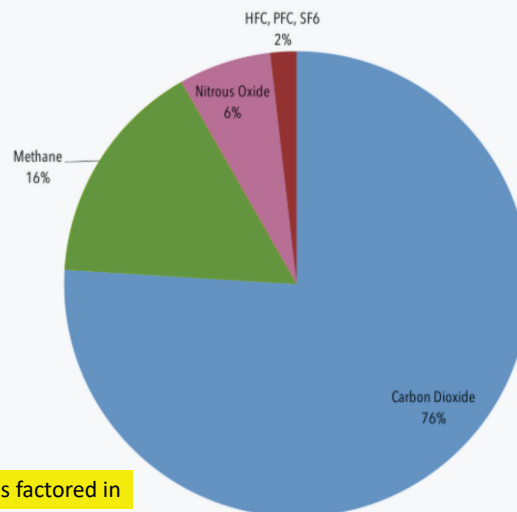
*(over 100-year time scale)*

13



13

## Global Manmade Greenhouse Gas Emissions by Gas, 2015

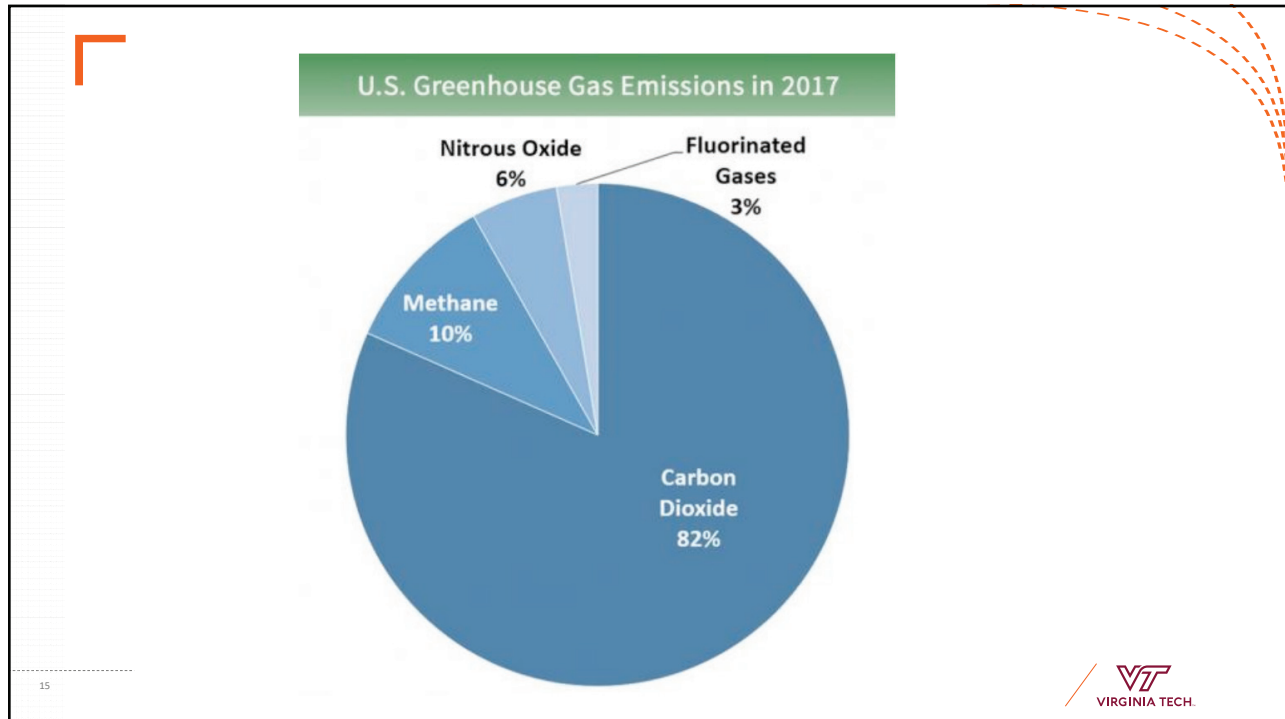


Concentrations factored in

14



14



15

## 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.

16



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

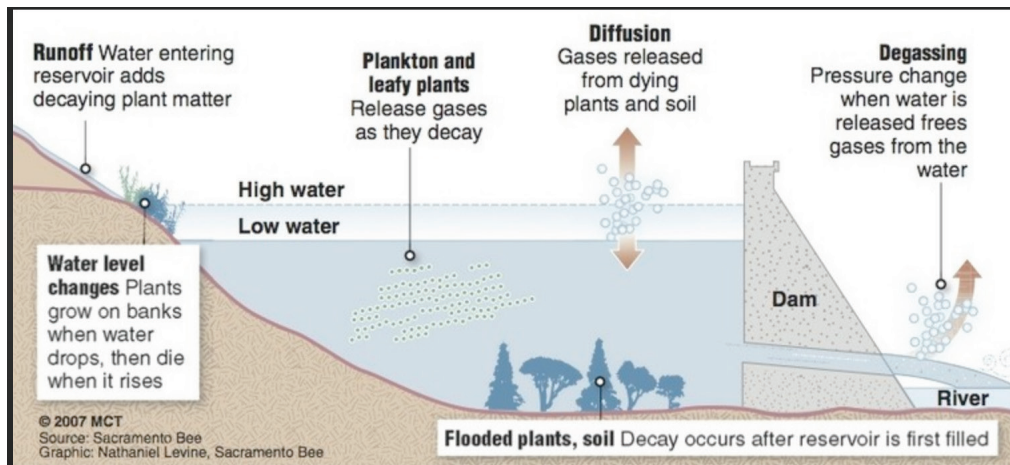
Plant Type	NO <sub>x</sub>	SO <sub>2</sub>	CO <sub>2</sub>
Gas	2.32	0.004	490
Oil	2.02	5.08	781
Coal	3.54	9.26	1090

17

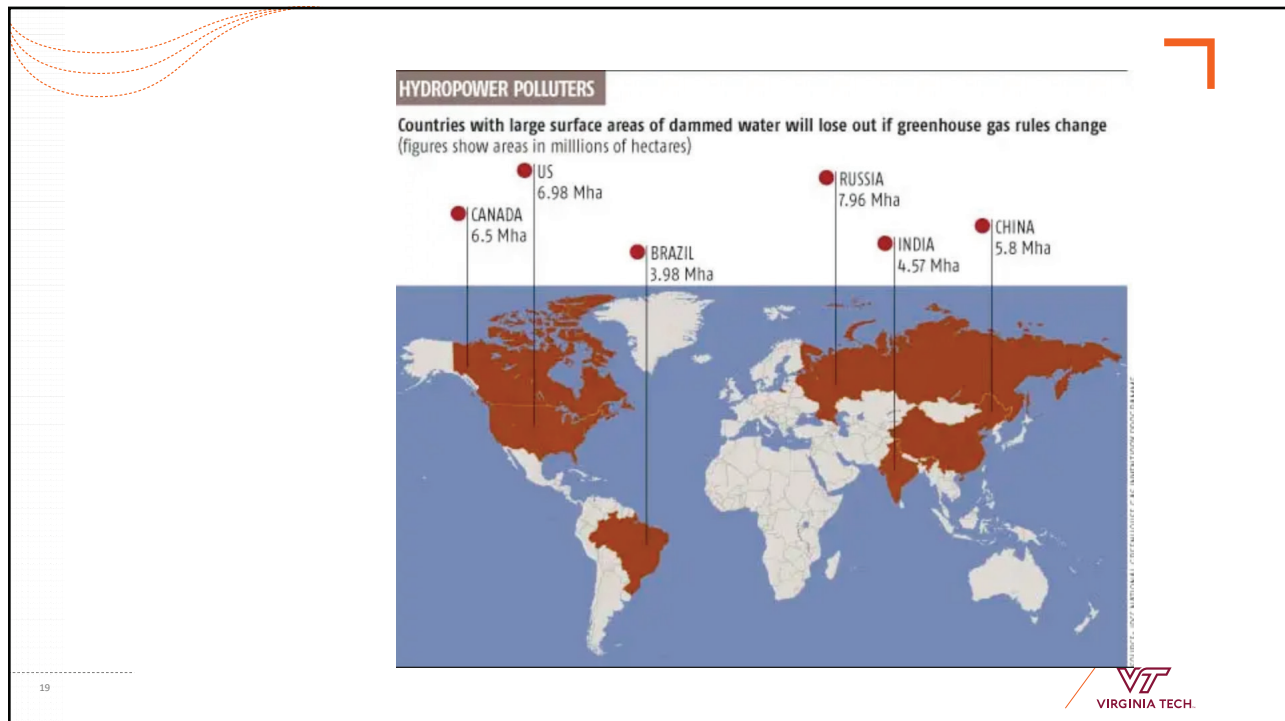


17

## Greenhouse Gases from Hydroelectricity



18



19

## Hydroelectricity is not Emission Free

One kWhr of **coal-based** electricity releases **1090 gm of CO<sub>2</sub>**

One kWhr of **hydro-based** electricity releases **225 gm of CO<sub>2</sub> equivalent**

One litre of **gasoline** releases **3.00 kg of CO<sub>2</sub>** from manufacture to consumption in a vehicle

20

VIRGINIA TECH.

20

## Reduce Carbon Emissions from Electricity Production

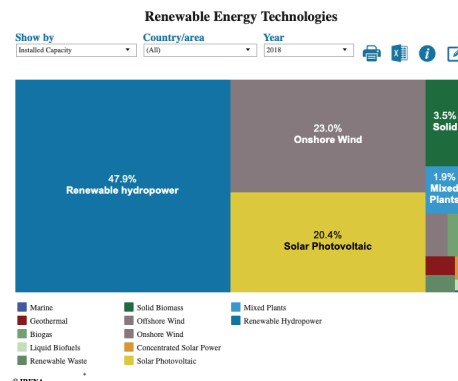
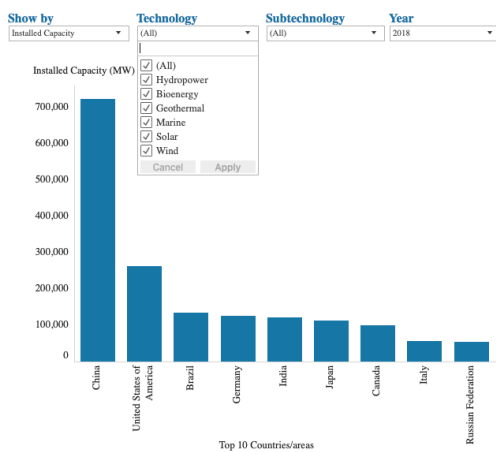
- (1) Use less electricity
- (2) Use less fuel to produce electricity
- (3) Produce more electricity from renewables & nuclear

21



21

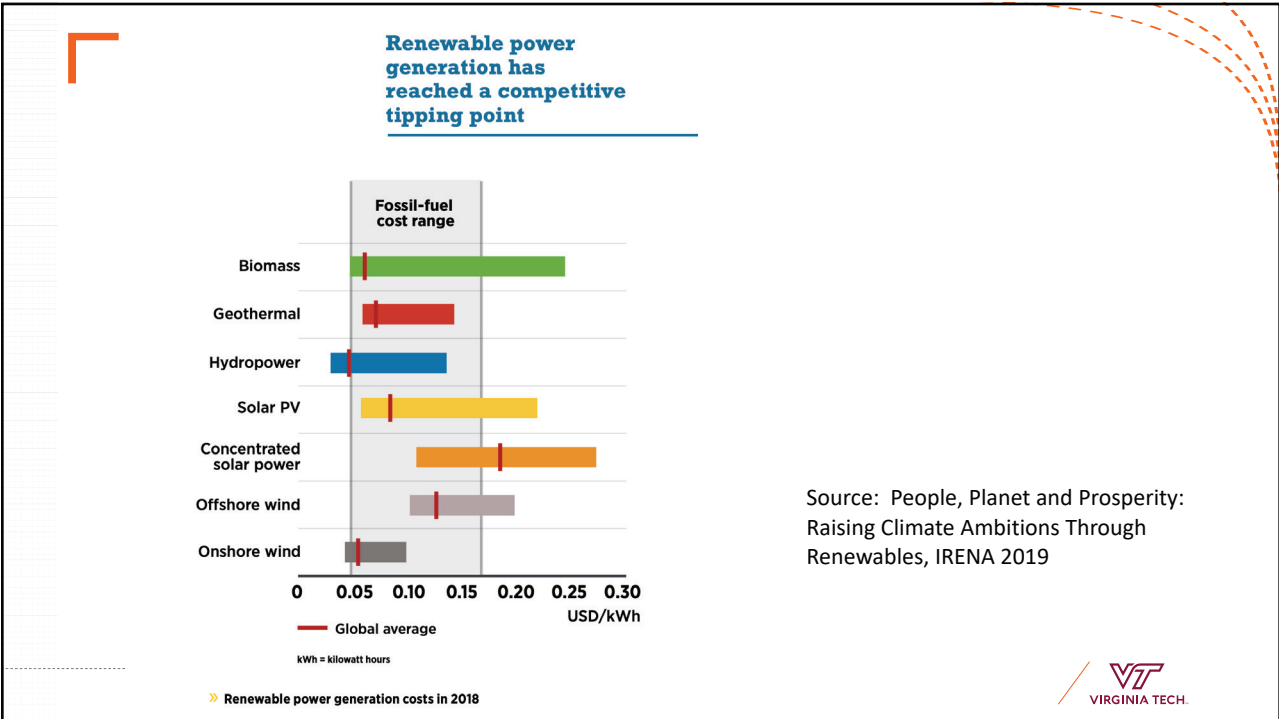
### Top Ten Countries Total Installed Renewable Energy Capacity in 2018



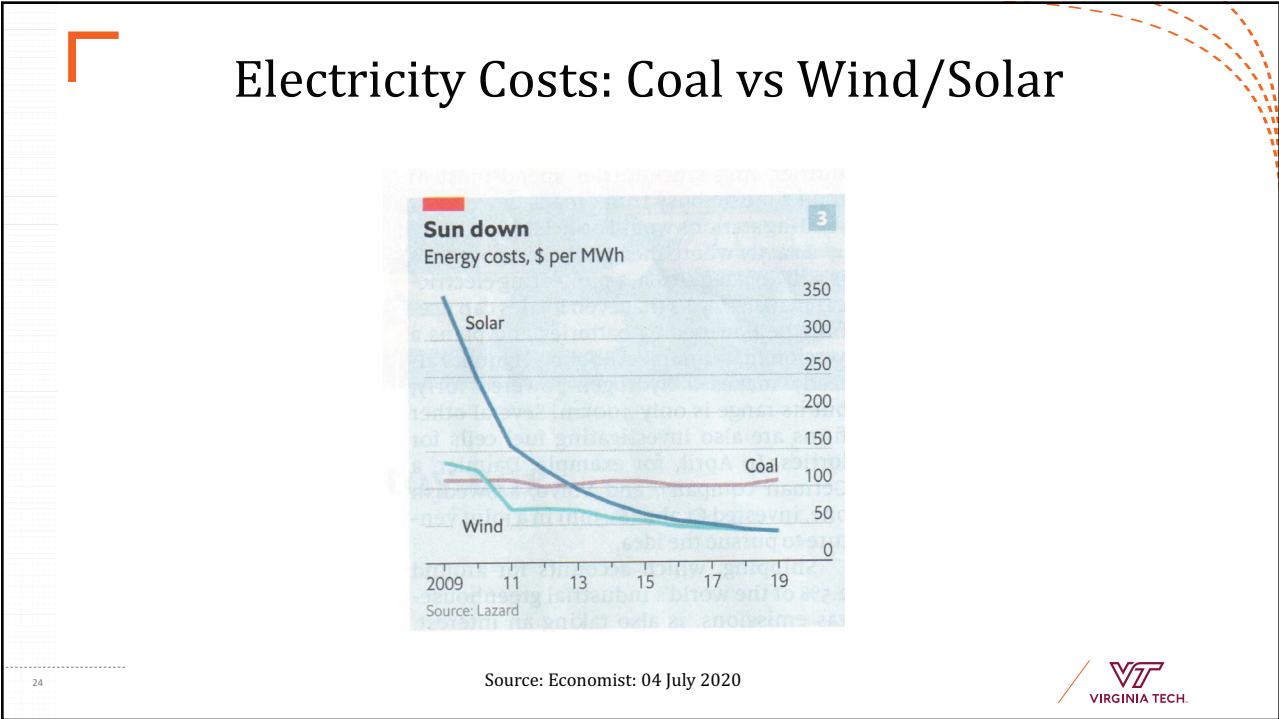
Source: International Renewable Energy Agency IRENA <https://www.irena.org/Statistics/>



22



23



24

## 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



25



25

## Message to the Young Generation



Focus on what you can do to reduce the Carbon Footprint

Don't ask why others are not doing their part

Show them what can be done



26



**Thank you**  
Prof. Saifur Rahman

[www.saifurrahman.org](http://www.saifurrahman.org)