



**Prof. Saifur
Rahman**



**2022 IEEE
President-elect**

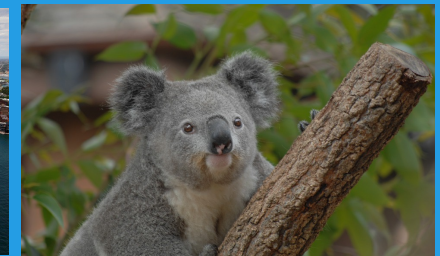
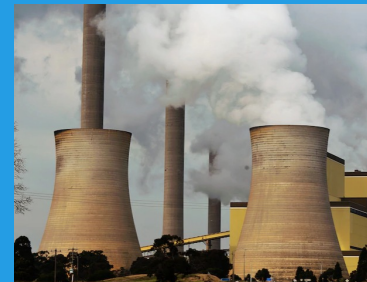
Director, Virginia
Tech Advanced
Research Inst., USA

Keynote Speech

Global Electric Power Sector: Engaging with Environmental Issues

24 Feb 2022

IEEE IAS/IES/PELS NSW,
Australia Chapter
Sydney, Australia



01 Global Warming
and Climate Change

02 Electricity Generation
Fuel Mix

03 A Portfolio of
Solutions

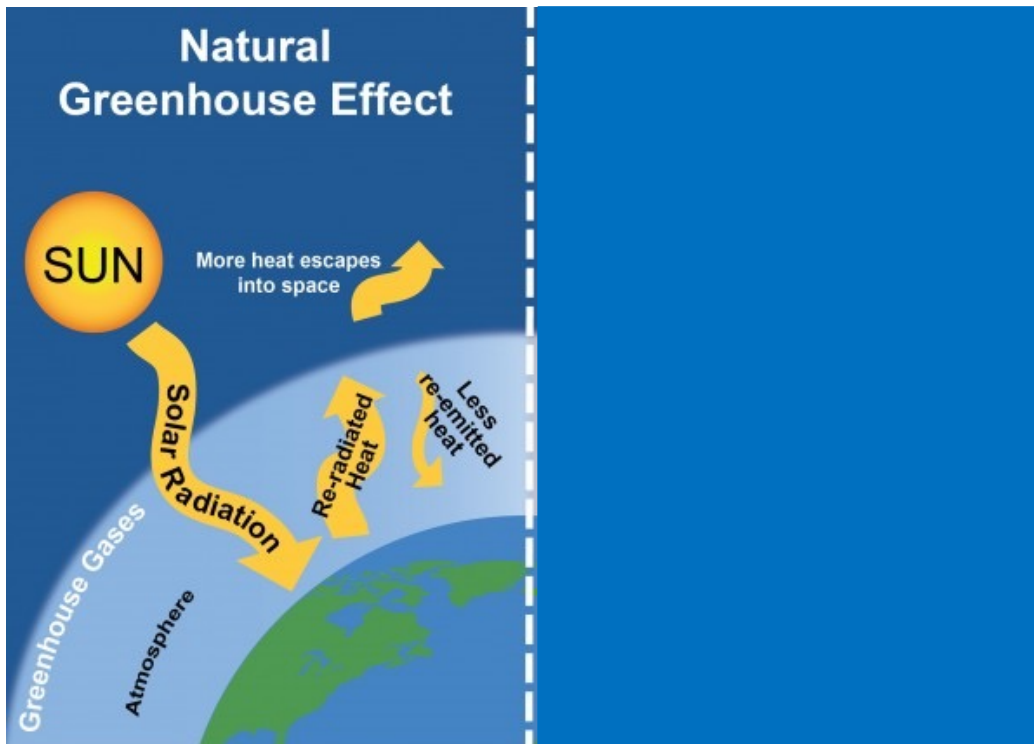


Weather vs Climate

“***Climate*** is what you expect, ***weather*** is what you get”.

Robert A. Heinlein

The Greenhouse Effect



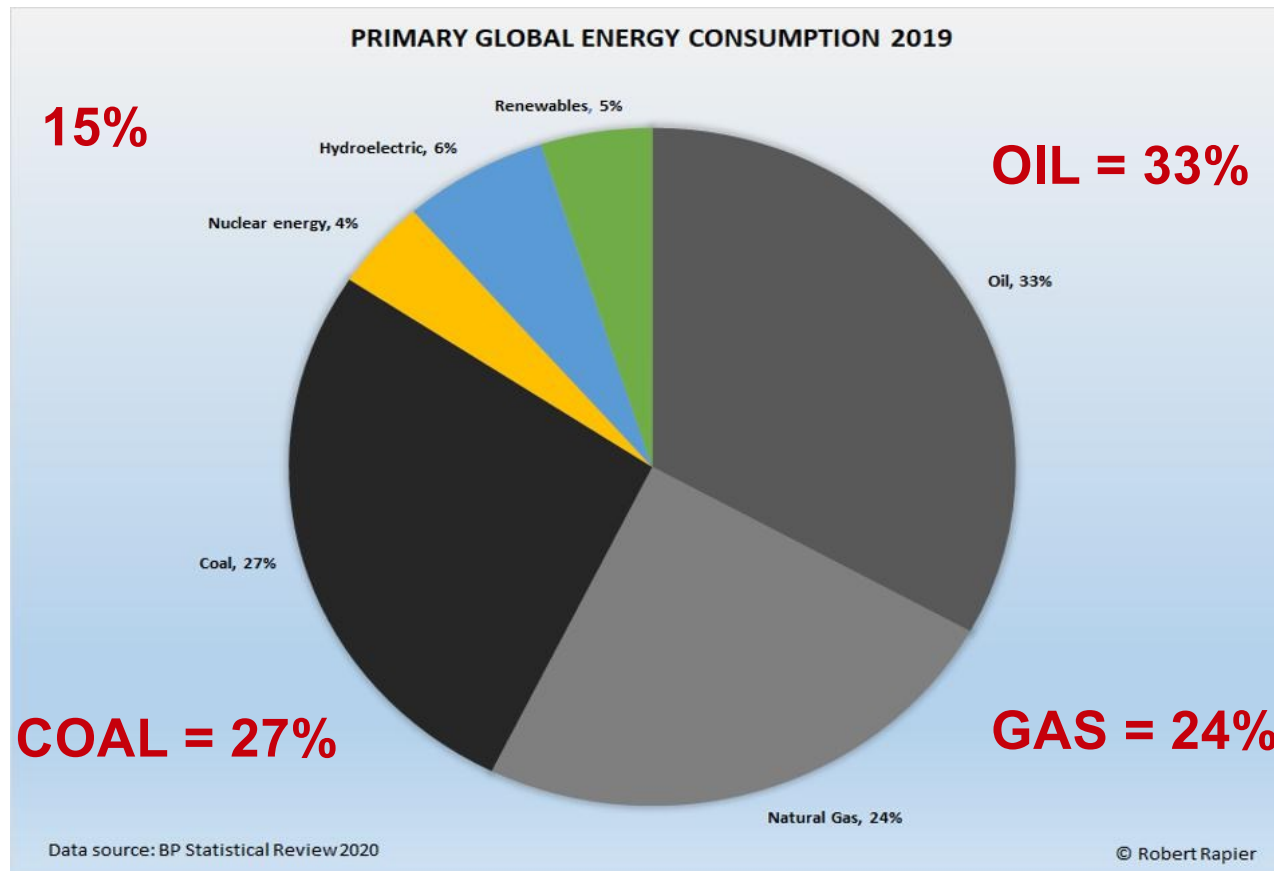
- Greenhouse gases (GHGs) naturally occur in Earth's atmosphere
- Without GHGs the average global temperature would be around 30°C lower than it is today.
- Human activity is increasing concentration of GHGs

Global Warming vs Climate change

Global warming – the long term trend of raising average global temperature.

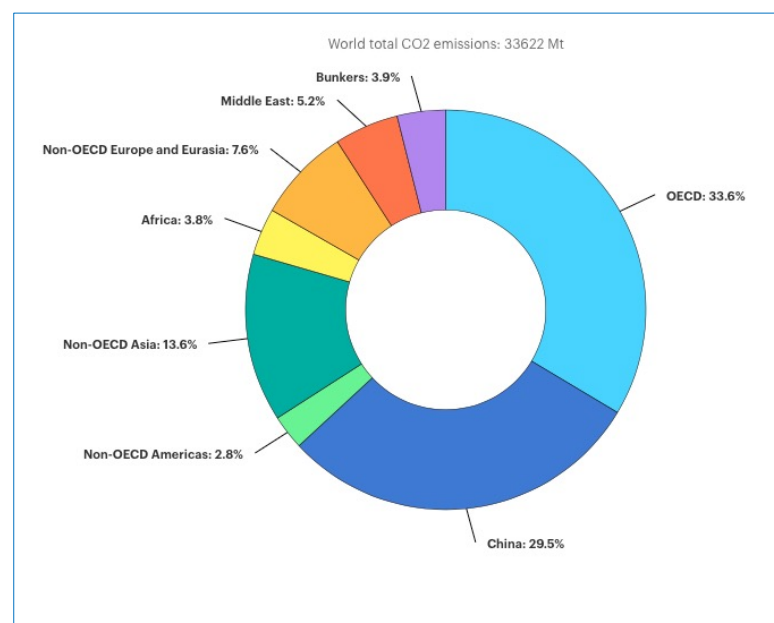
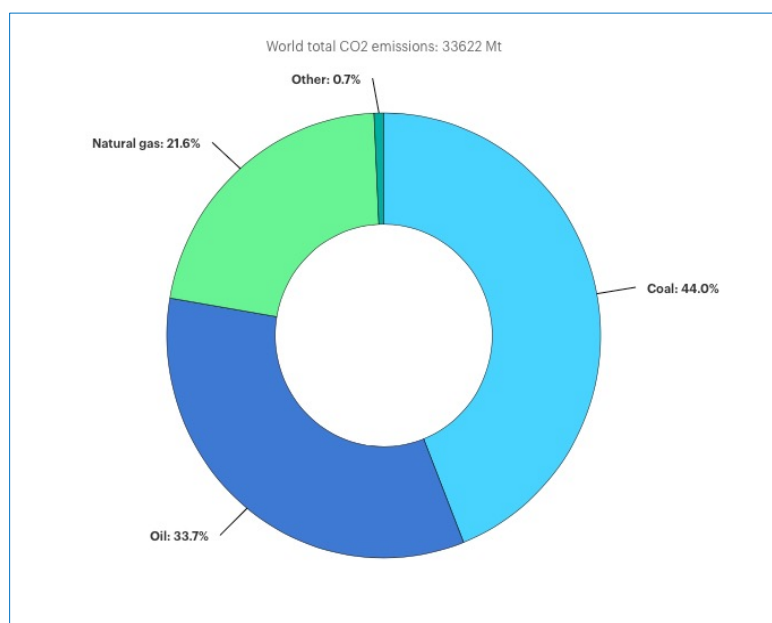
Climate change - changes in the global climate, resulting from the increasing average global temperature; e.g. changes in precipitation patterns, increased prevalence of droughts, heat waves, and other extreme weather.

GLOBAL ENERGY CONSUMPTION 2019



Needs To Reduce Emissions by 45% by 2030 & Net Zero by 2050 for 1.5C rise

CO₂ Emissions from Fuel Combustion by Source and Regions 2019 (33,622 Mt CO₂)



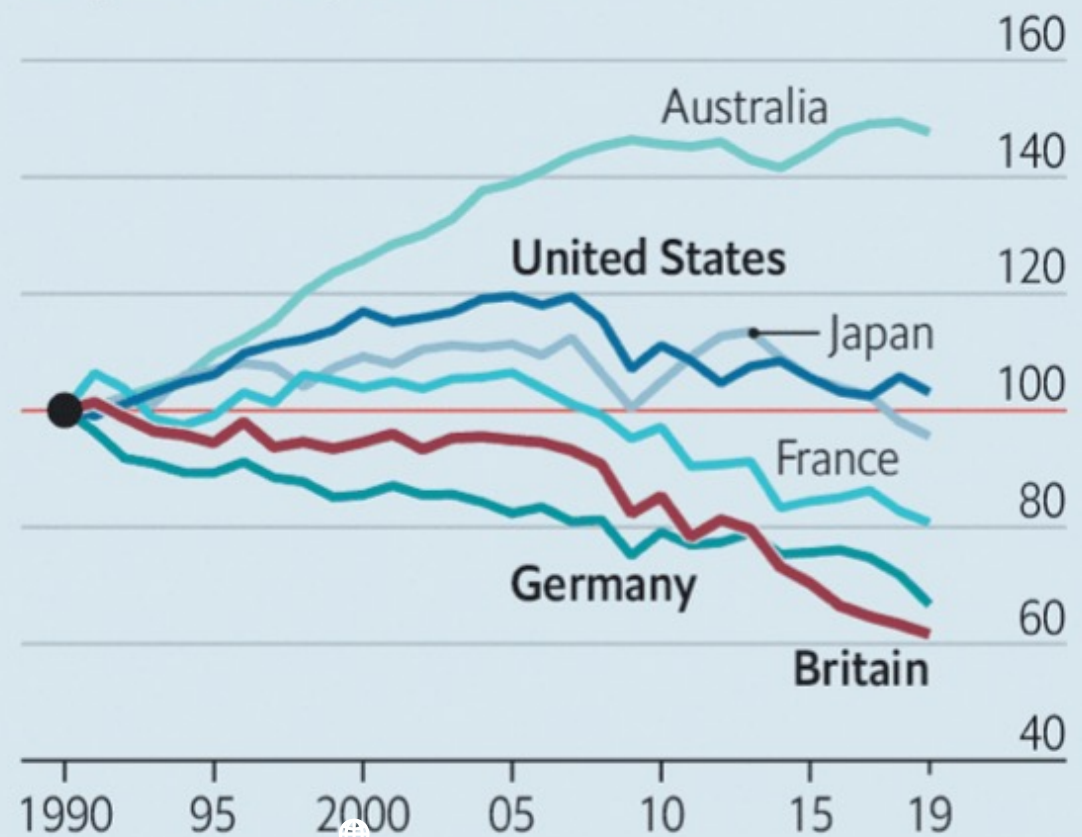
Source: IEA, Share of world CO₂ emissions from fuel combustion, 2019, IEA, Paris [Key World Energy Statistics 2021](https://www.iea.org/data-and-statistics/charts/share-of-world-co2-emissions-from-fuel-combustion-by-region-2019)
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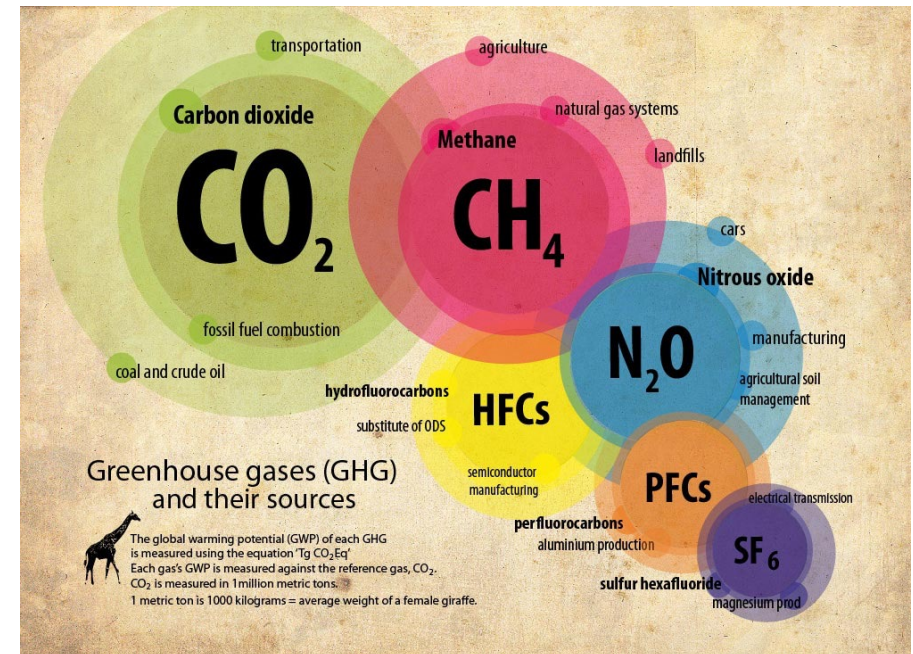
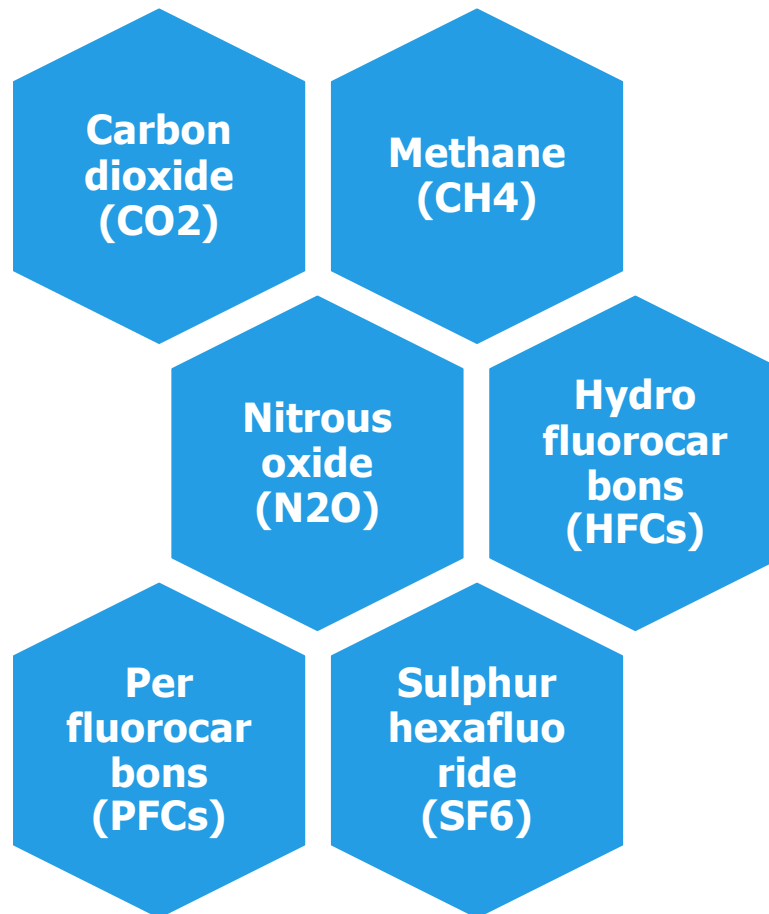
Cleaning up

Source: The Economist 20 Feb 2021

CO₂ emissions, 1990=100



Six Greenhouse Gases

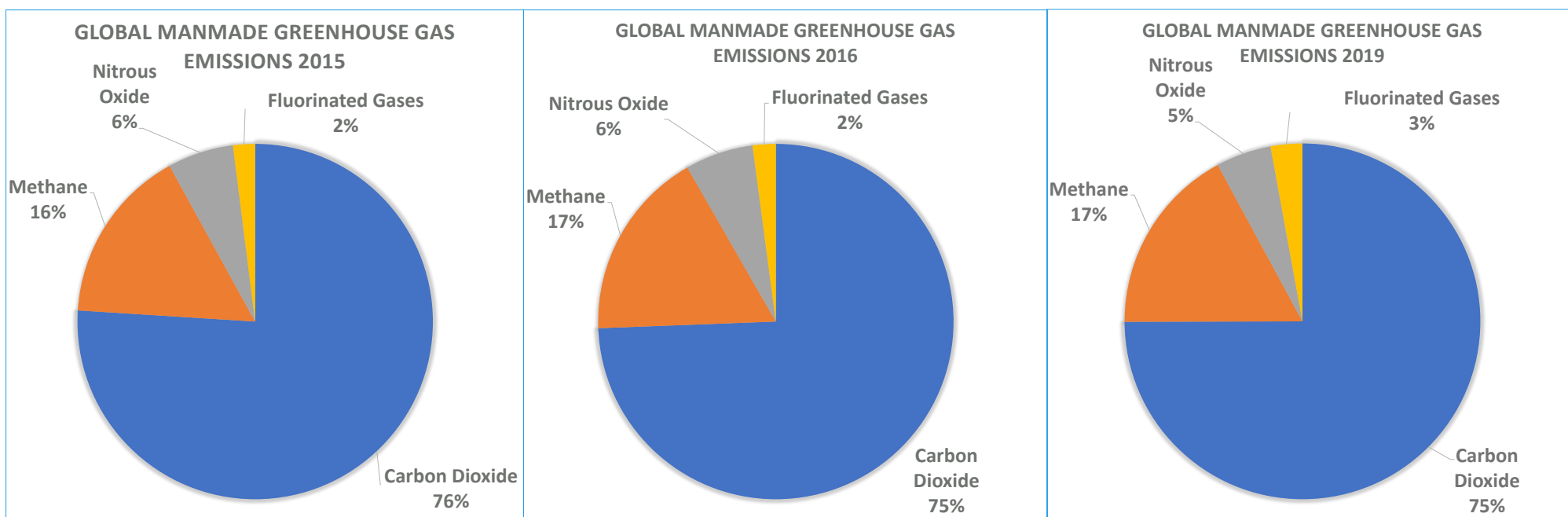


1997 CO₂ emissions from fossil fuels and cement production: 30.4 billion tons

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

Global Anthropogenic Greenhouse Gas Emissions by Gas 2015, 2016 & 2019

Fluorinated Gases include: HFC, PFC and SF6



Source: <https://www.c2es.org/content/international-emissions/>

Source: <https://ourworldindata.org/greenhouse-gas-emissions#annual-greenhouse-gas-emissions-how-much-do-we-emit-each-year>

Source: UNEP Emissions Gap Report 2020 <https://www.unep.org/emissions-gap-report-2020>

Global Warming Potential (GWP) of Greenhouse Gases



GLOBAL WARMING

- ✓ Carbon dioxide (CO₂): 1
- ✓ Methane (CH₄): 28
- ✓ Nitrous oxide (N₂O): 265
- ✓ Hydro fluorocarbons (HFCs): 138
- ✓ Per fluorocarbons (PFCs): 6,630
- ✓ Sulphur hexafluoride (SF₆): 23,500

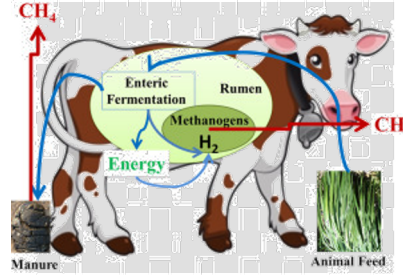
(over 100-year time scale)



Natural wetlands



Paddy rice fields



**Emission from livestock
production systems**



**Biomass burning
(including forest fires)**



**Anaerobic decomposition
of organic waste in
landfills**



**Fossil methane emission
during the exploration and
transport of fossil fuels**

Sources of Atmospheric Methane

WHAT WAS AGREED AT COP 26

US & CHINA COOPERATION

US and China agreed to work together this decade to limit global temperature rise to 1.5C including methane emissions, transition to clean energy and decarbonisation

No detail is yet available

COAL

More than 40 countries, including 23 new ones, have pledged to phase out coal including heavy coal users like Poland, Ukraine and Vietnam

Major countries to phase out coal in the 2030s - poorer countries in the 2040s

Excludes Australia, China, US & India

The COP agreement changes the wording on the Joint Declaration from countries to "phase out coal power and subsidies" to "phase down coal power and subsidies" implying a downward trend - but by how much and when?

Changes in Generation Mix in China



China will start to reduce its CO₂ emissions beginning in 2030

| 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 |

GHG Emissions Reduction/ Decarbonization Targets

| Country | 50% by | 100% by |
|---------|---------------------|---------|
| US | 2030 (Power Sector) | 2050 |
| EU | 2035 (All Sectors) | 2050 |
| China | 2030 (Power Sector) | 2060 |
| India | ---- | 2070 |

Create A Better Future



MINIMIZE
Energy Use & Switch
to Cleaner Fuels



GENERATE
Renewable
Energy



PURCHASE
Renewable Energy Credits
& Carbon Credits

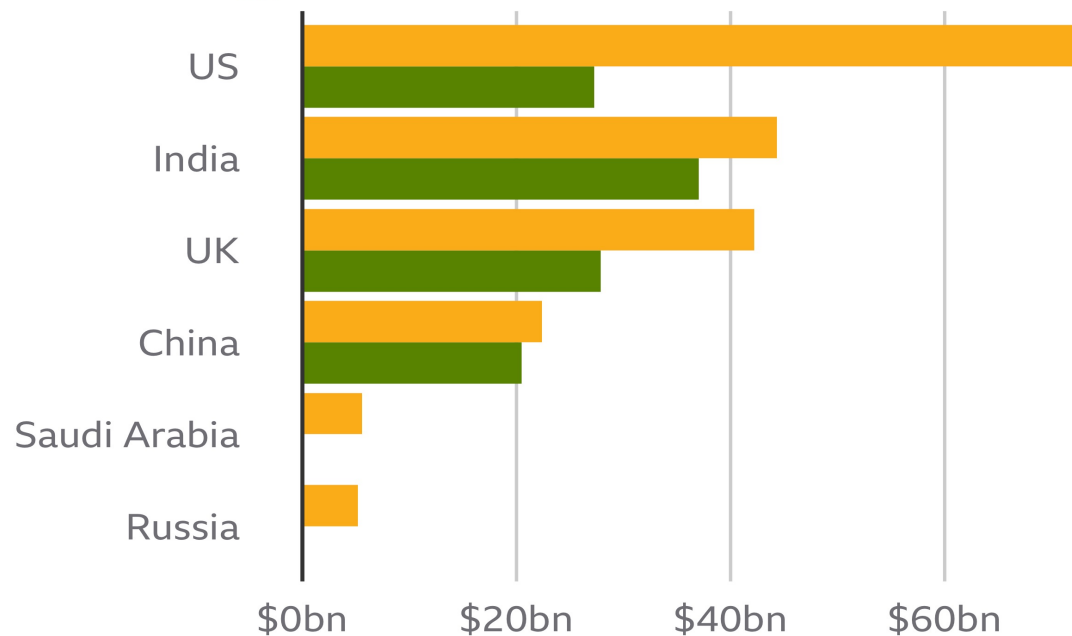


**ACHIEVE CARBON
NEUTRALITY**

FOSSIL FUEL SUBSIDIES

Energy industry subsidies through new or amended policies

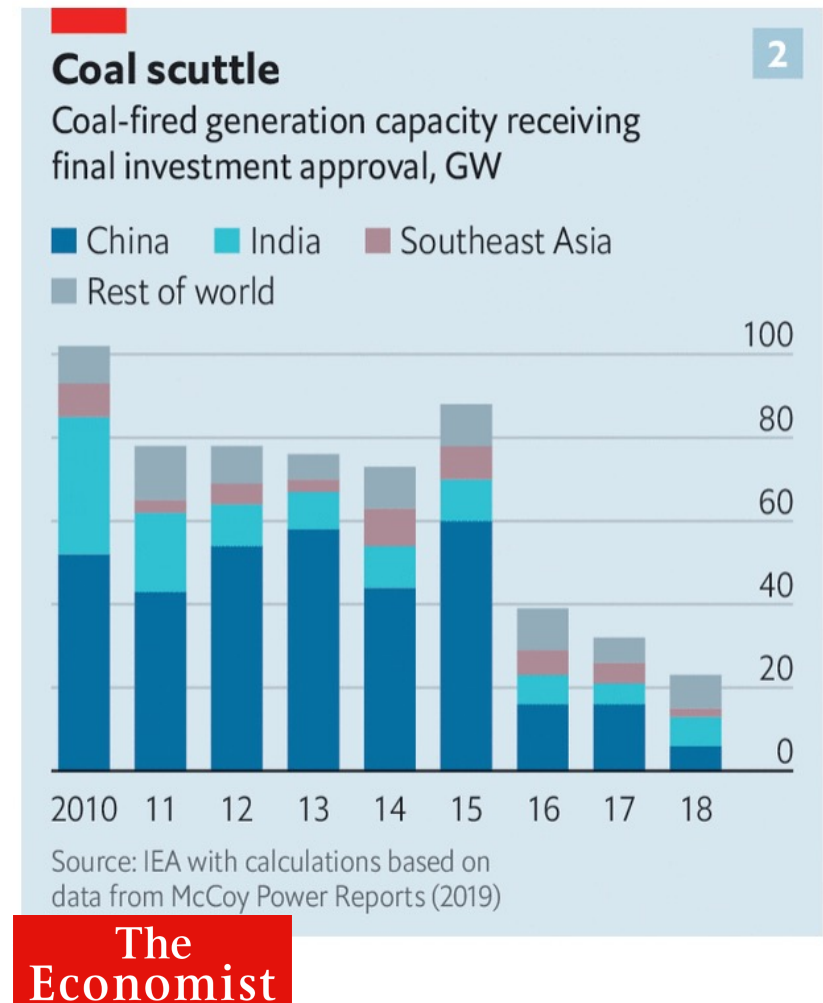
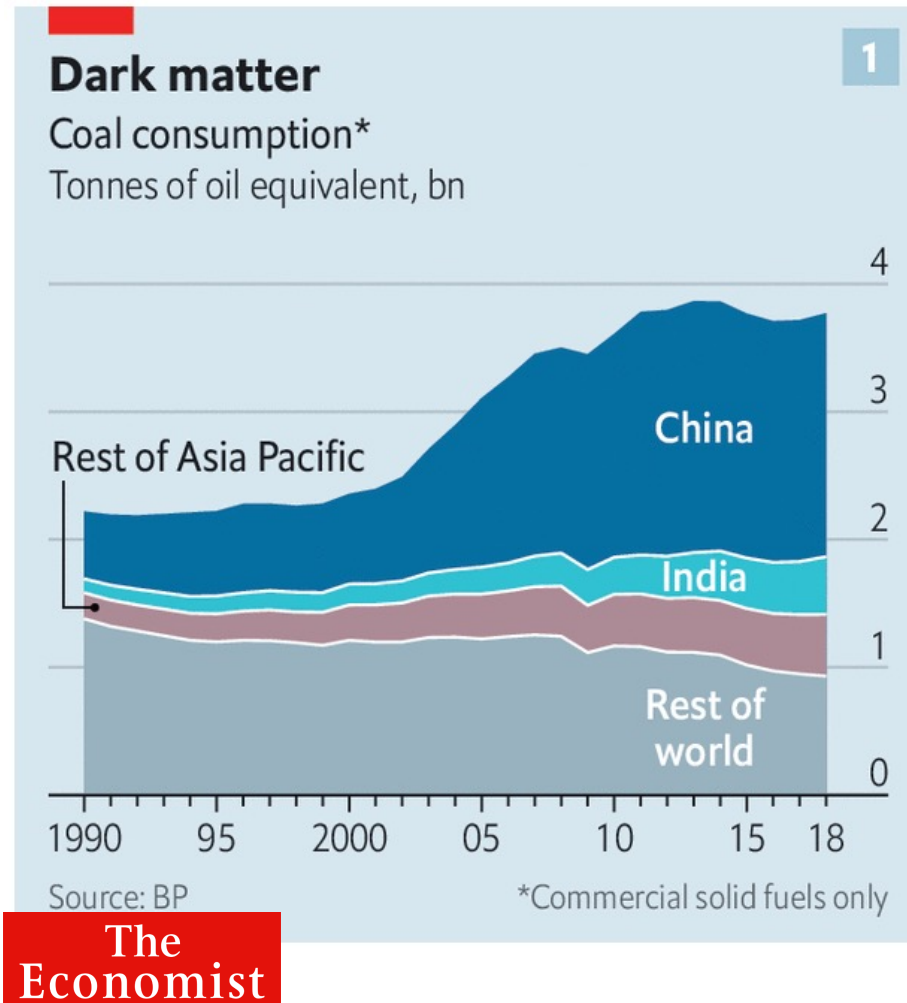
Government financial support for **fossil fuels** and **clean energy** since January 2020, selected countries

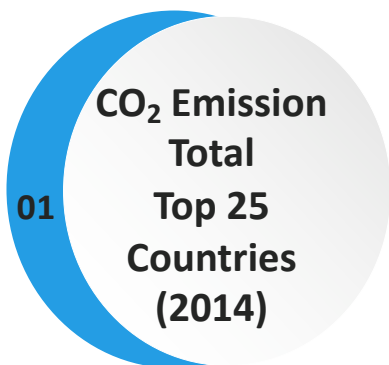


Source: Energy policy tracker

BBC

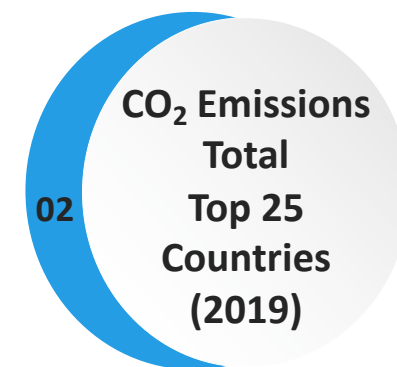
Over 75% of Global Demand for Coal Comes from Asia





| No. | Country | CO ₂ (10 ⁶ Tonnes) |
|-----|----------------|--|
| 1 | China | 9,820 |
| 2 | United States | 5,562 |
| 3 | EU-28 | 3,484 |
| 4 | India | 2,184 |
| 5 | Russia | 1,622 |
| 6 | Japan | 1,263 |
| 7 | Germany | 793 |
| 8 | Iran | 642 |
| 9 | Saudi Arabia | 602 |
| 10 | South Korea | 587 |
| 11 | Canada | 576 |
| 12 | Brazil | 524 |
| 13 | South Africa | 482 |
| 14 | Mexico | 481 |
| 15 | United Kingdom | 439 |
| 16 | Indonesia | 417 |
| 17 | Australia | 394 |
| 18 | Turkey | 362 |
| 19 | Italy | 348 |
| 20 | France | 334 |
| 21 | Poland | 310 |
| 22 | Thailand | 280 |
| 23 | Kazakhstan | 279 |
| 24 | Taiwan | 261 |
| 25 | Ukraine | 258 |
| 63 | Bangladesh | 66 |

| No. | Country | CO ₂ (10 ⁶ Tonnes) |
|-----|----------------|--|
| 1 | China | 10,175 |
| 2 | United States | 5,285 |
| 3 | EU-28 | 3,287 |
| 4 | India | 2,616 |
| 5 | Russia | 1,678 |
| 6 | Japan | 1,107 |
| 7 | Iran | 780 |
| 8 | Germany | 702 |
| 9 | Indonesia | 618 |
| 10 | South Korea | 611 |
| 11 | Saudi Arabia | 582 |
| 12 | Canada | 577 |
| 13 | South Africa | 479 |
| 14 | Brazil | 466 |
| 15 | Mexico | 438 |
| 16 | Australia | 411 |
| 17 | Turkey | 405 |
| 18 | United Kingdom | 370 |
| 19 | Italy | 337 |
| 20 | France | 324 |
| 21 | Poland | 323 |
| 22 | Kazakhstan | 314 |
| 23 | Thailand | 288 |
| 24 | Taiwan | 263 |
| 25 | Spain | 253 |
| 57 | Bangladesh | 102 |



Source: Our World in Data (<https://eithub.com/owid/co2-data>)

01

**CO₂ Emissions
per Capita
Top 25
Countries
(2014)**

| No. | Country | CO ₂ per capita (tonnes) |
|-----|----------------|-------------------------------------|
| 1 | Saudi Arabia | 19.47 |
| 2 | United States | 17.45 |
| 3 | Australia | 16.70 |
| 4 | Canada | 16.15 |
| 5 | Kazakhstan | 16.11 |
| 6 | South Korea | 11.59 |
| 7 | Russia | 11.21 |
| 8 | Taiwan | 11.12 |
| 9 | Japan | 9.86 |
| 10 | Germany | 9.73 |
| 11 | South Africa | 8.84 |
| 12 | Iran | 8.29 |
| 13 | Poland | 8.14 |
| 14 | China | 7.02 |
| 15 | EU-28 | 6.86 |
| 16 | United Kingdom | 6.71 |
| 17 | Italy | 5.76 |
| 18 | Ukraine | 5.71 |
| 19 | France | 5.20 |
| 20 | Turkey | 4.68 |
| 21 | Thailand | 4.09 |
| 22 | Mexico | 4.00 |
| 23 | Brazil | 2.58 |
| 24 | India | 1.69 |
| 25 | Indonesia | 1.63 |
| 192 | Bangladesh | 0.43 |

| No. | Country | CO ₂ per capita (tonnes) |
|-----|----------------|-------------------------------------|
| 1 | Saudi Arabia | 16.99 |
| 2 | Kazakhstan | 16.92 |
| 3 | Australia | 16.31 |
| 4 | United States | 16.06 |
| 5 | Canada | 15.41 |
| 6 | South Korea | 11.93 |
| 7 | Russia | 11.51 |
| 8 | Taiwan | 11.05 |
| 9 | Iran | 9.40 |
| 10 | Japan | 8.72 |
| 11 | Poland | 8.52 |
| 12 | Germany | 8.41 |
| 13 | South Africa | 8.17 |
| 14 | China | 7.10 |
| 15 | EU-28 | 6.41 |
| 16 | Italy | 5.57 |
| 17 | United Kingdom | 5.48 |
| 18 | Spain | 5.41 |
| 19 | France | 4.97 |
| 20 | Turkey | 4.86 |
| 21 | Thailand | 4.14 |
| 22 | Mexico | 3.44 |
| 23 | Indonesia | 2.28 |
| 24 | Brazil | 2.21 |
| 25 | India | 1.92 |
| 183 | Bangladesh | 0.63 |

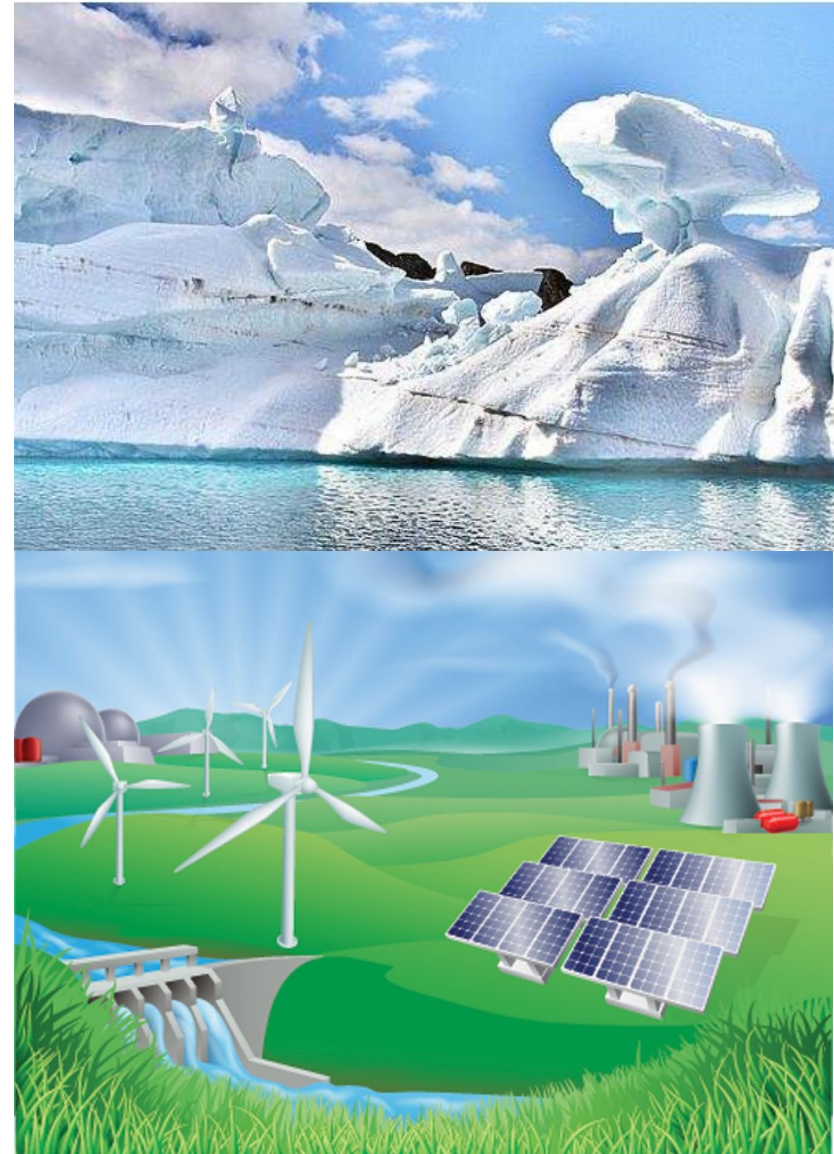
02

**CO₂ Emissions
per Capita
Top 25
Countries
(2019)**

Source: Our World in Data (<https://github.com/owid/co2-data>)

The Decarbonization Debate

- Industrialized countries want emerging countries to cut carbon emissions.
- Emerging economies want to continue using fossil fuel for electricity production
- There is a third way – Use a diverse portfolio of solutions



Reduce Carbon Emissions from Electricity Production



Reduce Carbon Emissions

1. Use less electricity, energy efficiency
2. Use low carbon fossil fuel power plants
3. Use H₂ & other storage technologies
4. Promote more renewables
5. Accept some nuclear
6. Promote cross-border power transfer

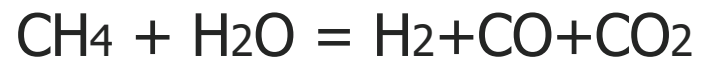
Building Automation System Optimized for Savings

- Heating, Ventilation and central AC systems
- Lighting systems
- 20% or more energy savings
- Healthy building air quality

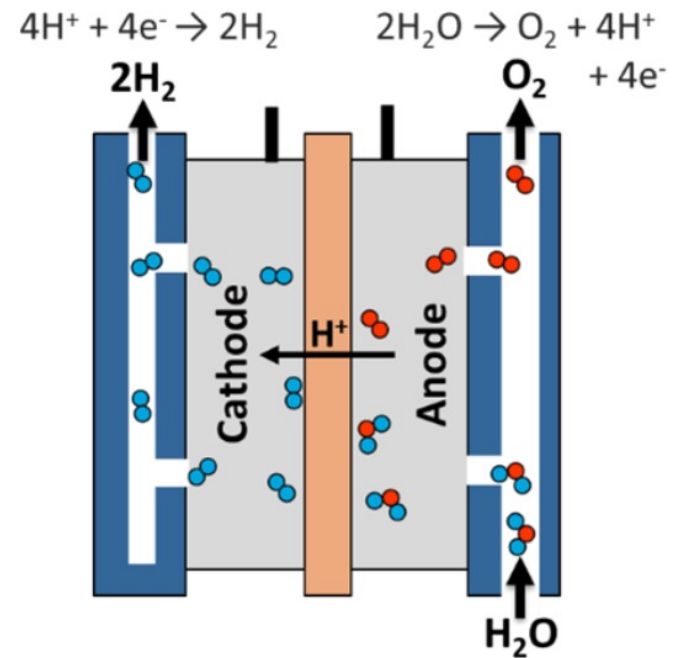


Hydrogen Economy

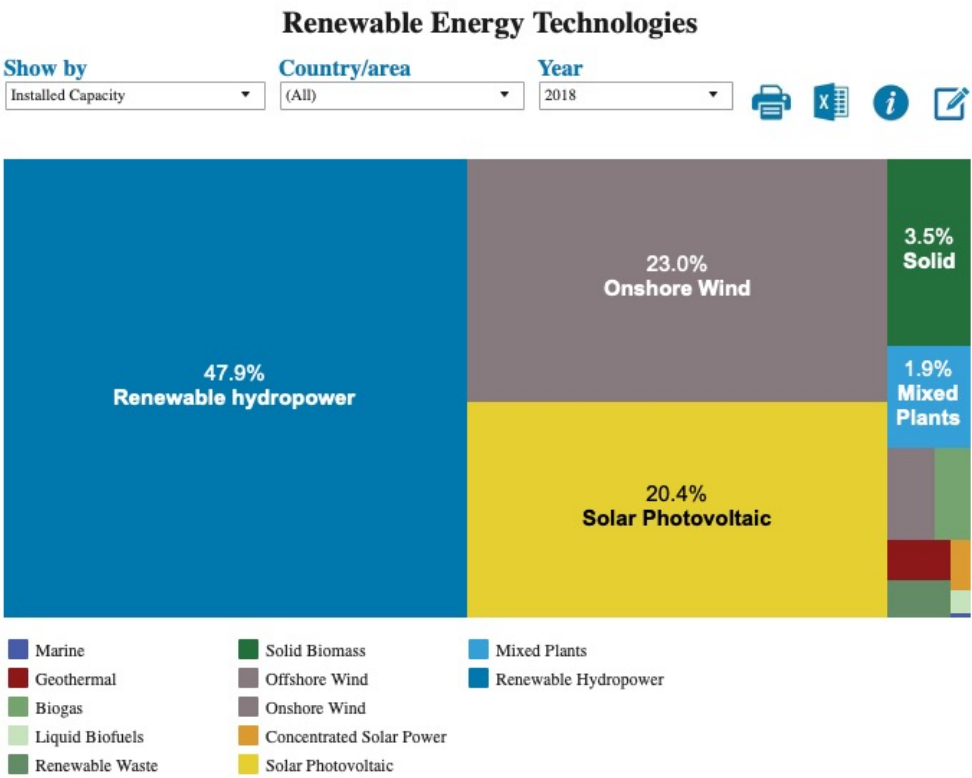
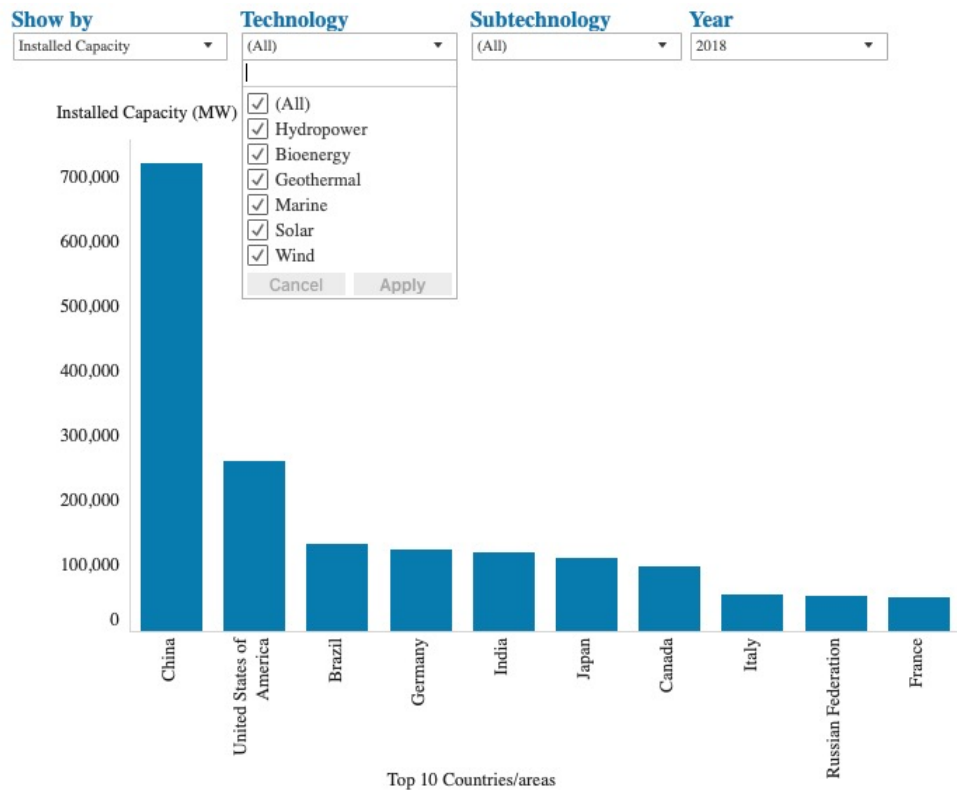
High Temperature Steam/
Natural Gas Reforming



Electrolysis

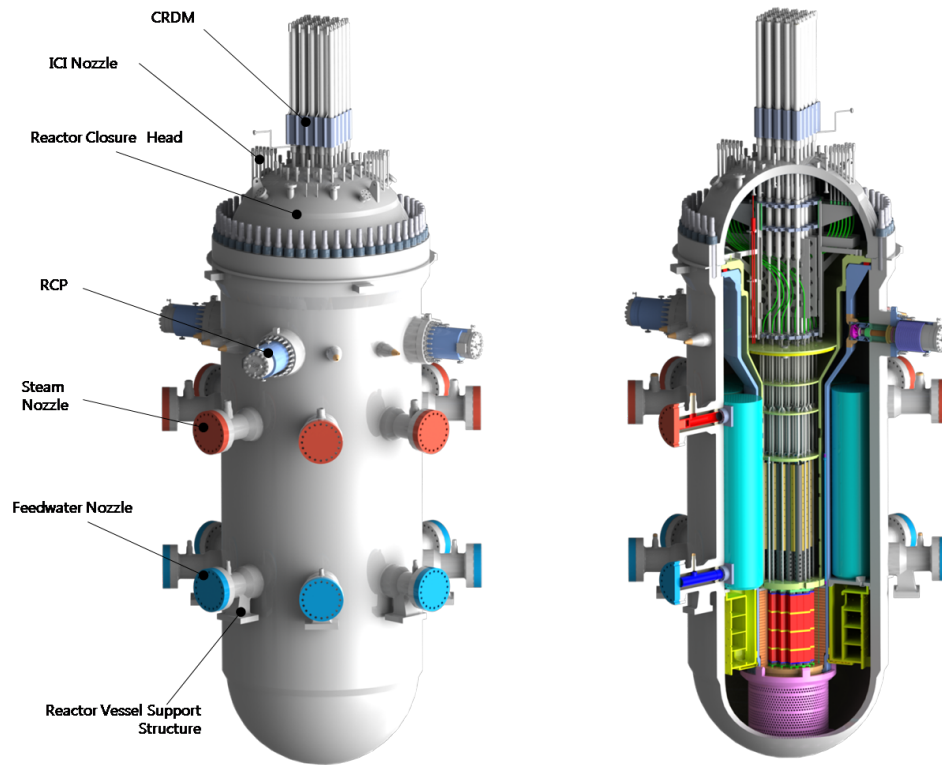


Total Installed Renewable Energy Capacity Top Ten Countries (2018)

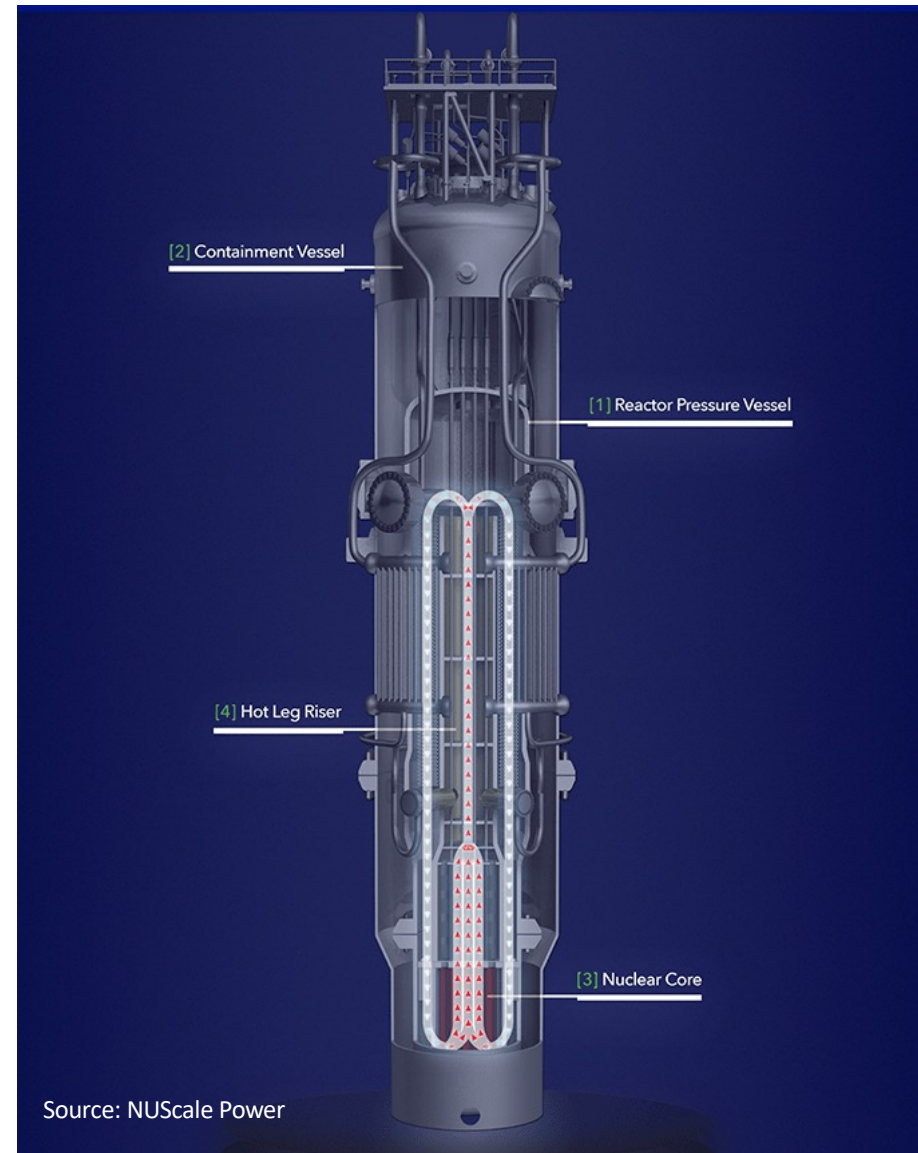


Source: International Renewable Energy Agency IRENA
<https://www.irena.org/Statistics/>

Small Modular Reactors (SMR)



20m tall, 2.7m dia. 590 tons LWR
4.95% enrichment 50 – 60 MWe



IEEE Response to Climate Change

Committee to Coordinate IEEE's Response to Climate Change (CCIRCC)

Provides a platform for presenting alternatives –

Participation from IEEE technical committees involved in power engineering (including renewables and nuclear), energy departments in national governments, CIGRE (the French version of IEEE), national engineering societies and central electricity authorities in several countries, and vendors.

***Please Share your Idea in My Twitter Account To
“make IEEE a more successful and resilient global technical organization”***



@SRahmanVT



SCAN ME



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IEEE PRESIDENT-ELECT 2022**

THANK YOU!

www.srahman.org