

**ICEE Conference, Hong Kong
03 July 2023**

Keynote Speech

**Decarbonization Opportunities in the
Electric Power Sector to Address Climate Change**

Prof. Saifur Rahman

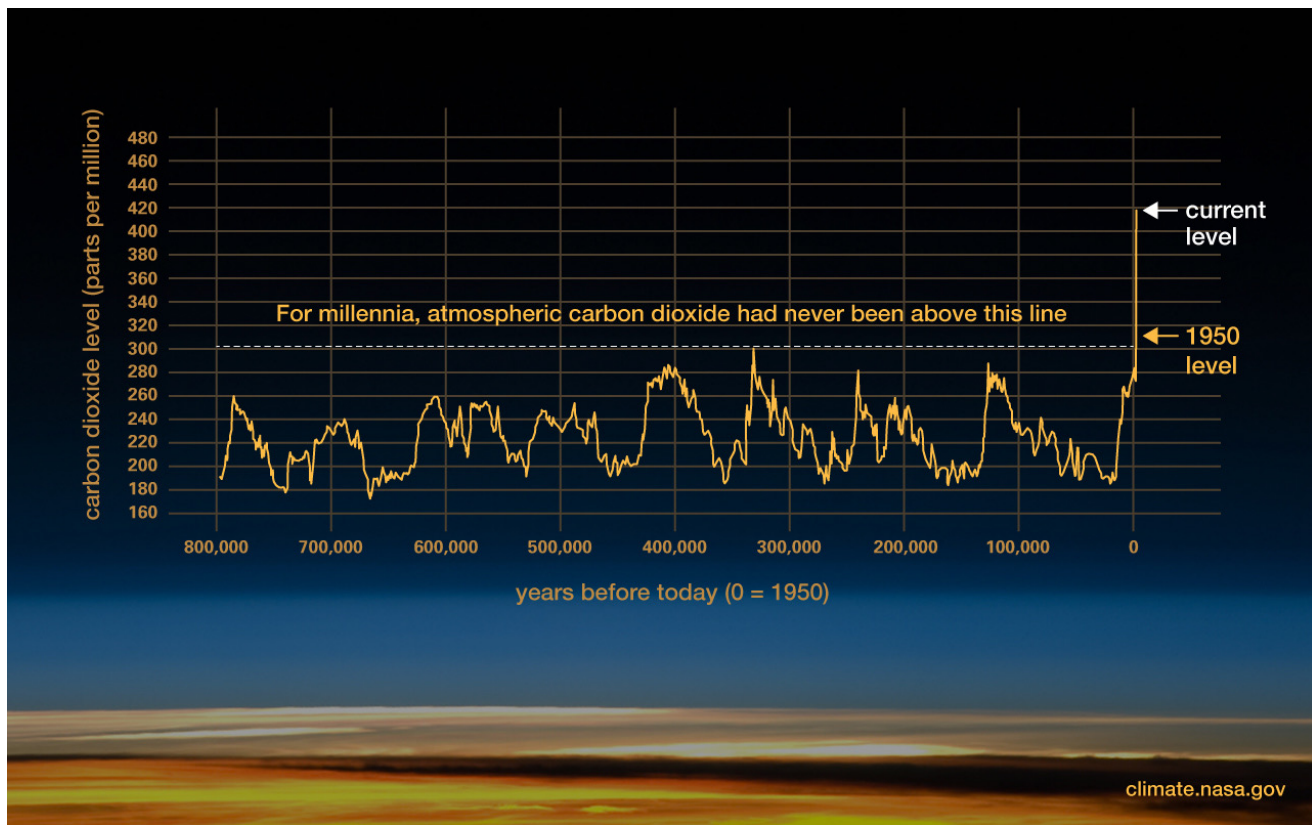
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**Director, Virginia Tech
Advanced Research
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www.srahman.org**

Frontiers in Carbon Neutrality Power and Energy

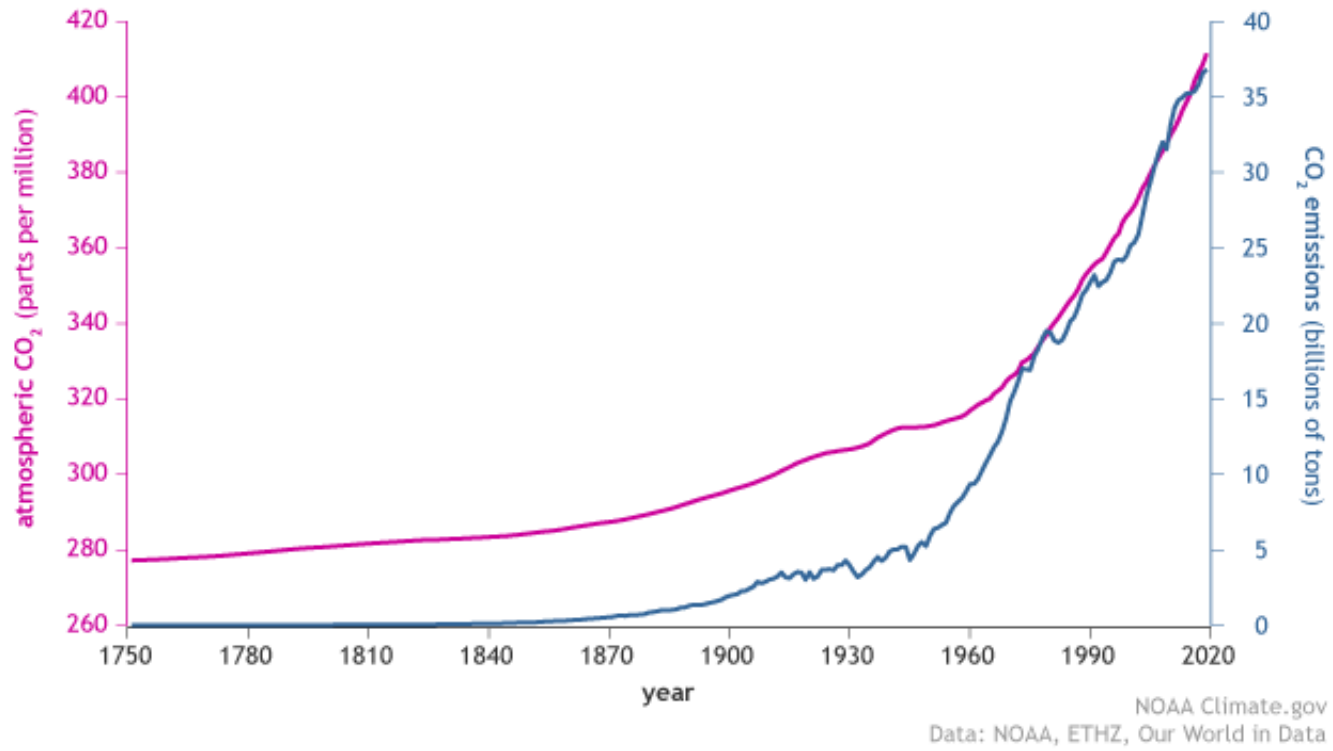
What is Carbonization ?



Source: NASA

https://climate.nasa.gov/climate_resources/24/graphic-the-relentless-rise-of-carbon-dioxide/

CO₂ in the atmosphere and annual emissions (1750-2019)



Source: State of the Planet

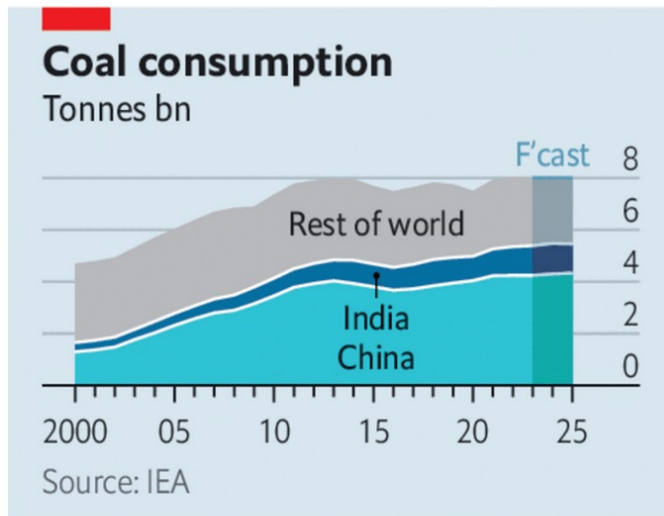
<https://news.climate.columbia.edu/2021/02/25/carbon-dioxide-cause-global-warming/>

Global CO₂ Emissions Due to Fossil Fuels in 2021

Coal	15.3 billion tons
Nat. Gas	7.5 billion tons
Oil	10.7 billion tons

Source: IEA Global Energy Review: CO₂ Emissions in 2021
<https://www.iea.org/reports/global-energy-review-co2-emissions-in-2021-2>

Growth in Coal Usage



The Economist

CO₂ Emissions from Electricity Production

Coal: 1.0 kg/kWh

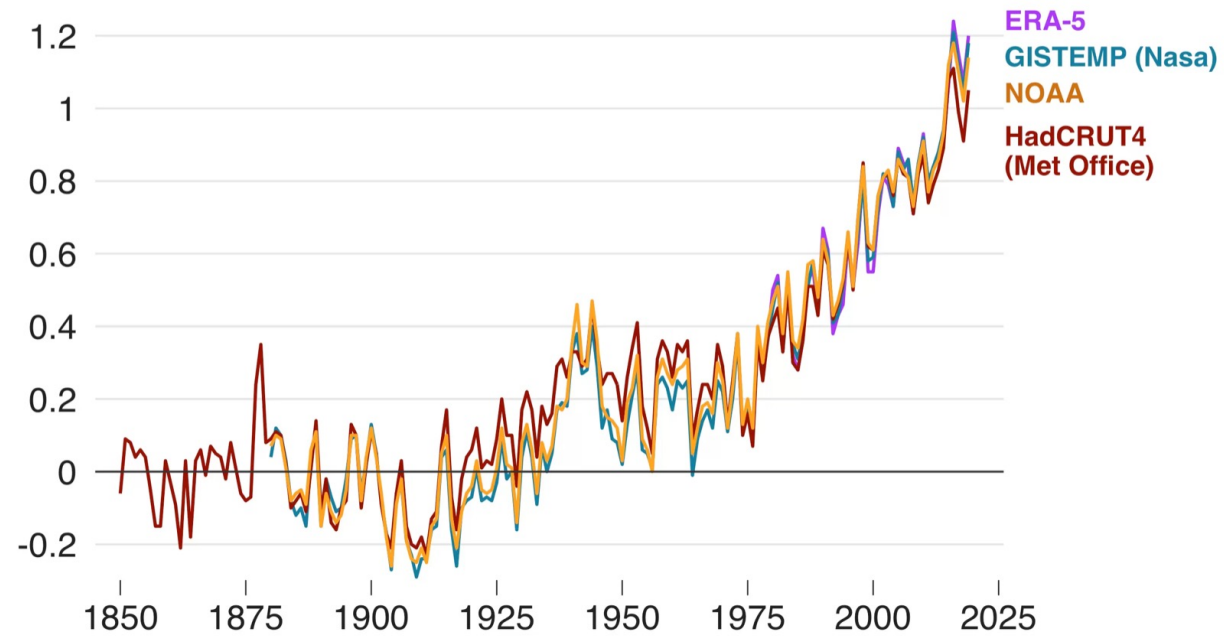
Oil: 0.75 kg/kWh

Gas: 0.50 kg/kWh

Impacts of Carbonization

Temperature rise since 1850

Global mean temperature change from pre-industrial levels, °C



Source: Met Office

BBC

Source: <https://www.bbc.com/news/science-environment-51111176>

Temperature rise of 1.5 – 2.0 °C = Point of No Return



Source: Craig Dearden-Phillips: Don't be a polar bear
<https://www.thirdsector.co.uk/craig-dearden-phillips-dont-polar-bear/management/article/1488091>

Climate Change Hits
Poor and the Rich Alike

Florida, China and Africa





Hurricane Isabel struck the Mid-Atlantic region of USA between Sept. 18-19, 2003.

Flooding in Pakistan – August 2022



Source: <https://www.npr.org/sections/pictureshow/2022/08/30/1119979965/pakistan-floods-monsoon-climate>



Source: <https://www.nytimes.com/2022/09/07/briefing/climate-change-heat-waves-us-europe.html>



China





Hurricane Sandy

New York, New Jersey 2012



Droughts in 2022



Dry river bed in **Italy** (Po River) due to worst drought in 70 years, June 2022

<https://idsb.tmgrup.com.tr/ly/uploads/images/2022/07/08/217454.jpg>

The Jialing Riverbed at the confluence with the Yangtze River is exposed due to drought on August 18, 2022 in Chongqing, **China**.



<https://image.cnbcfm.com/>

Wildfires in the US



July 2021 - The Dixie fire burned close to a million acres in **California's** Lassen county over three months and became the first fire to cross the Sierra Nevada. Photograph: Noah Berger/AP

Peaks glowing with thousands of spot fires on June 13, 2022 in Flagstaff, **Arizona**.
Schumacher/The Republic



Wildfires in Europe - Summer of 2022



Southwestern **France**, July 17, 2022



Central **Portugal**, July 13, 2022



Brandenburg, **Germany**, August 2022



Greece, July 2022



Northern **Spain**, June 2022



Central **Italy**, July 2022

“The number of wildfires in 2022 in the EU have nearly quadrupled the 15-year average”

[Source: CNN according to Copernicus, EU Earth observation program](#)

Siberia: Wildfires in June 2020 and June 2021



The Greenpeace Russia team has documented forest fires in the Krasnoyarsk region.
JULIA PETRENKO / GREENPEACE



In this June 16, 2021 photo, firefighters work at the scene of forest fire near Andreyevsky village outside Tyumen, western Siberia, Russia. -
Copyright AP Photo/Maksim Slutsky, File

2008 China Snowstorm



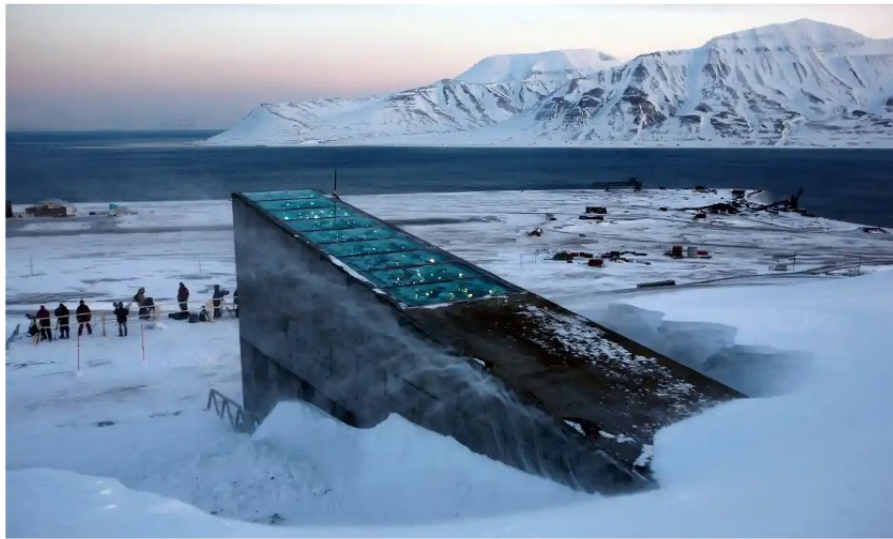
Glacier Comparison Mer de Glace in France, 2012



The Global Seed Vault in Svalbard, Norway

Arctic stronghold of world's seeds flooded after permafrost melts

No seeds were lost but the ability of the rock vault to provide failsafe protection against all disasters is now threatened by climate change



The Svalbard 'doomsday' seed vault was built to protect millions of food crops from climate change, wars and natural disasters. Photograph: John Mcconnico/AP

Source: [The Guardian, May2017](https://www.theguardian.com/environment/2017/may/17/svalbard-seed-vault)



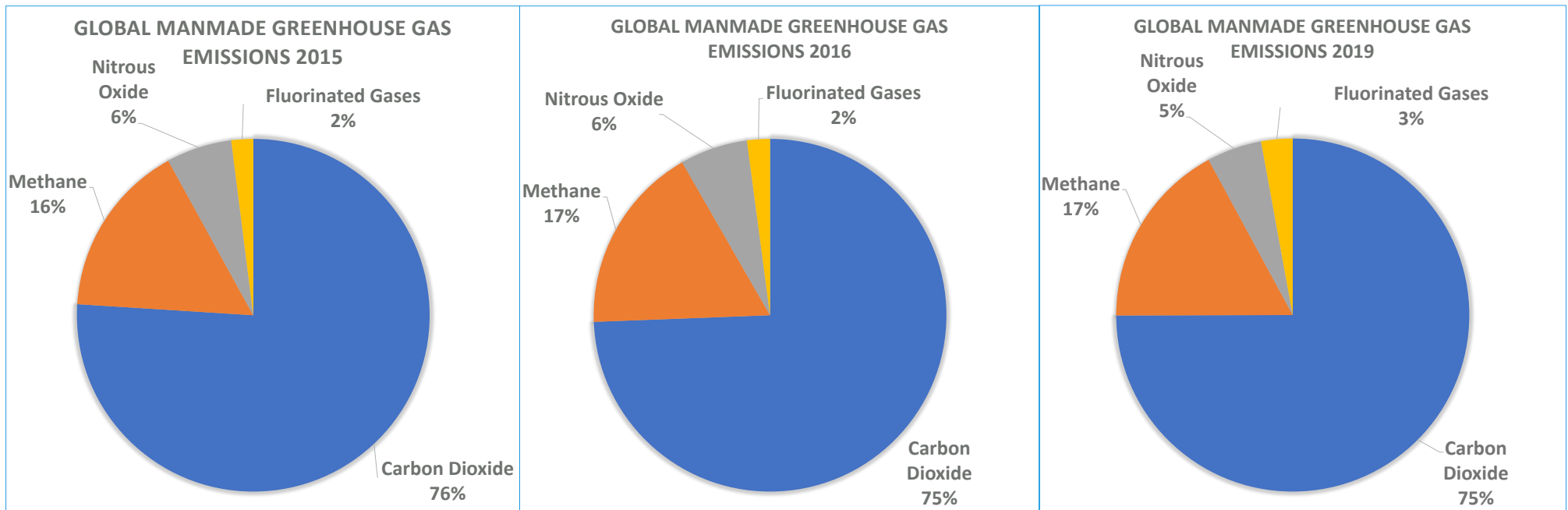
Entrance to the Svalbard Global Seed Vault (SGSV), on the island of Spitsbergen, Norway. HEIKO JUNGE/AFP/GETTY IMAGES



[Svalbard Global Seed Vault Protects...](https://www.nationalgeographic.com/science/2017/05/17/svalbard-seed-vault-protects-worlds-seeds/)
[nationalgeographic.com](https://www.nationalgeographic.com)

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

Fluorinated Gases include: HFC, PFC and SF6

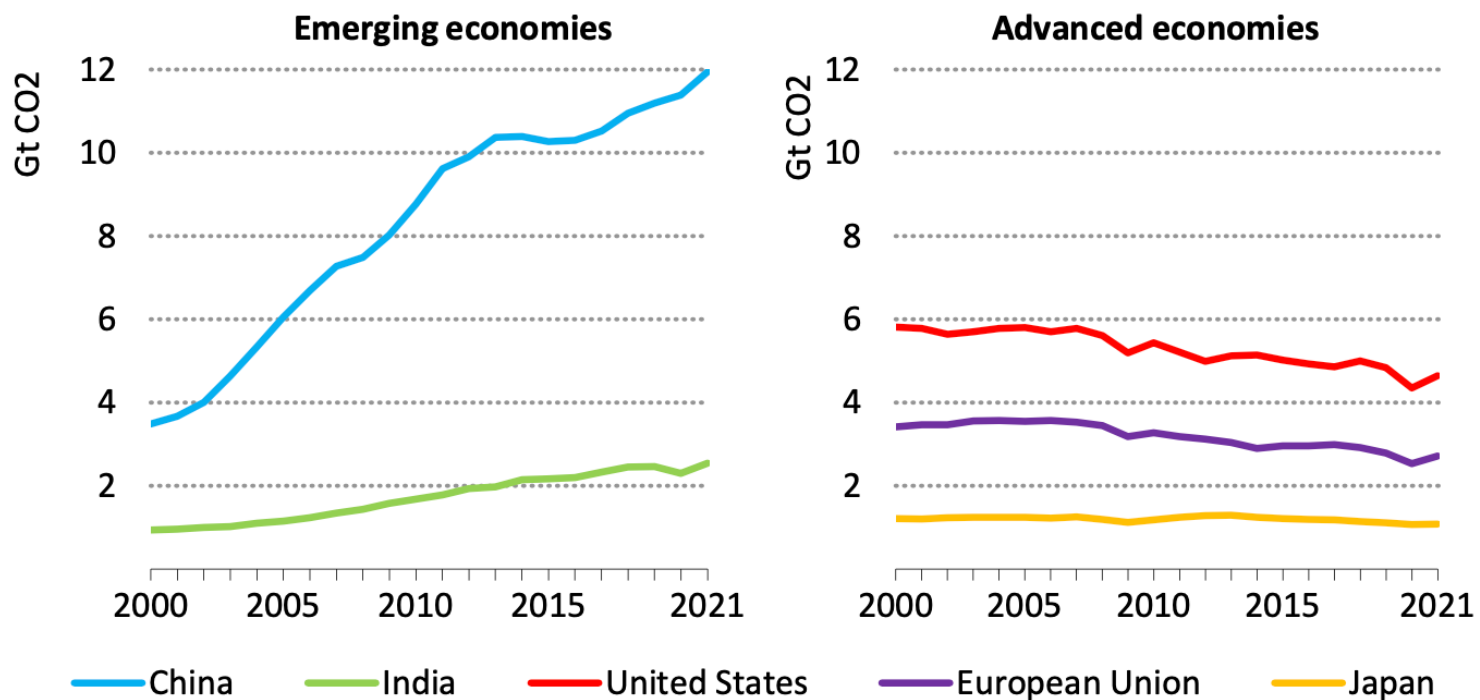


Source: <https://www.c2es.org/content/international-emissions/>

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>

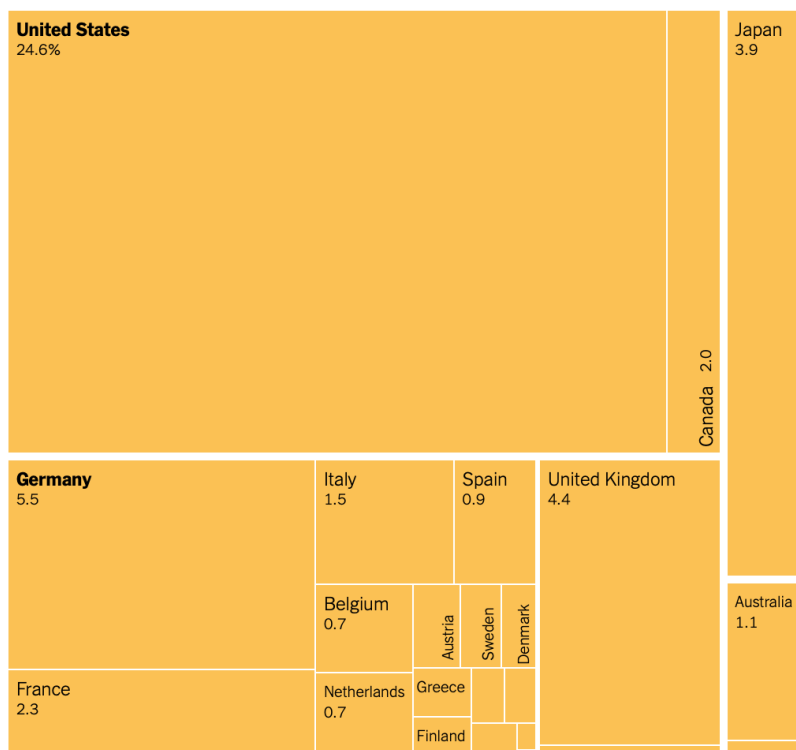
CO2 emissions in selected emerging and advanced economies, 2000-2021



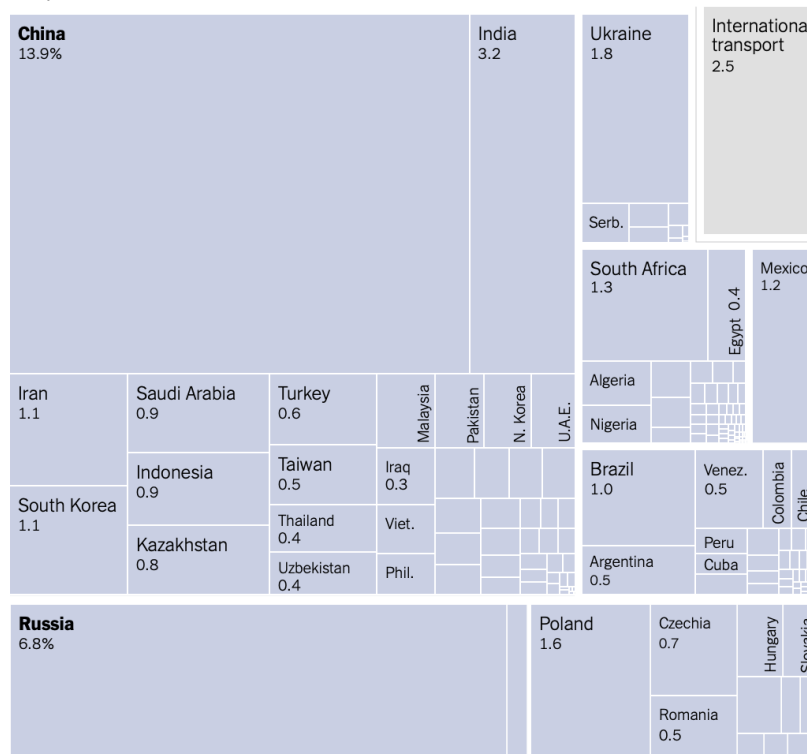
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Who Has The Most Historical Responsibility for Climate Change

23 rich, developed countries are responsible for half of all historical CO₂ emissions.



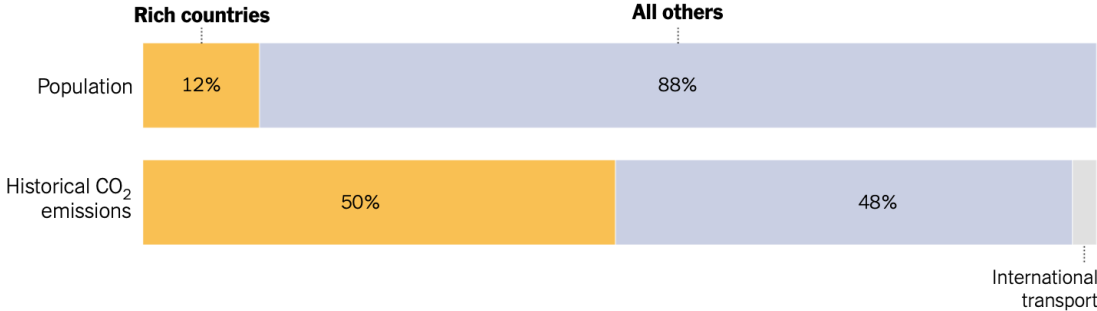
More than 150 countries are responsible for the other half.



Source: The New York Times article "Who Has The Most Historical Responsibility for Climate Change?" by [Nadja Popovich](#) and [Brad Plumer](#), Nov. 12, 2021 (<https://www.nytimes.com/interactive/2021/11/12/climate/cop26-emissions-compensation.html>)

Who Has The Most Historical Responsibility for Climate Change

Rich countries, including the United States, Canada, Japan and much of western Europe, account for just 12 percent of the global population today but are responsible for 50 percent of all the planet-warming greenhouse gases released from fossil fuels and industry over the past 170 years.



Source: The New York Times article "Who Has The Most Historical Responsibility for Climate Change?" by [Nadja Popovich](#) and [Brad Plumer](#), Nov. 12, 2021 (<https://www.nytimes.com/interactive/2021/11/12/climate/cop26-emissions-compensation.html>)

- Navigating the tension between industrialized nations and emerging economies for global decarbonization efforts requires a diverse portfolio of solutions for low-carbon generation, storage and demand side management with advanced technology focusing on energy efficiency.
- To more efficiently facilitate the global shift towards carbon neutrality in the electric power sector, the following six areas should be our priority.

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

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



IEEE Climate Change Program

<https://climate-change.ieee.org>



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A banner image featuring a landscape with wind turbines, solar panels, and a dam. The text "MAKING A DIFFERENCE" is overlaid in white, with "MAKING A" in a smaller font above "DIFFERENCE".

MAKING A
DIFFERENCE

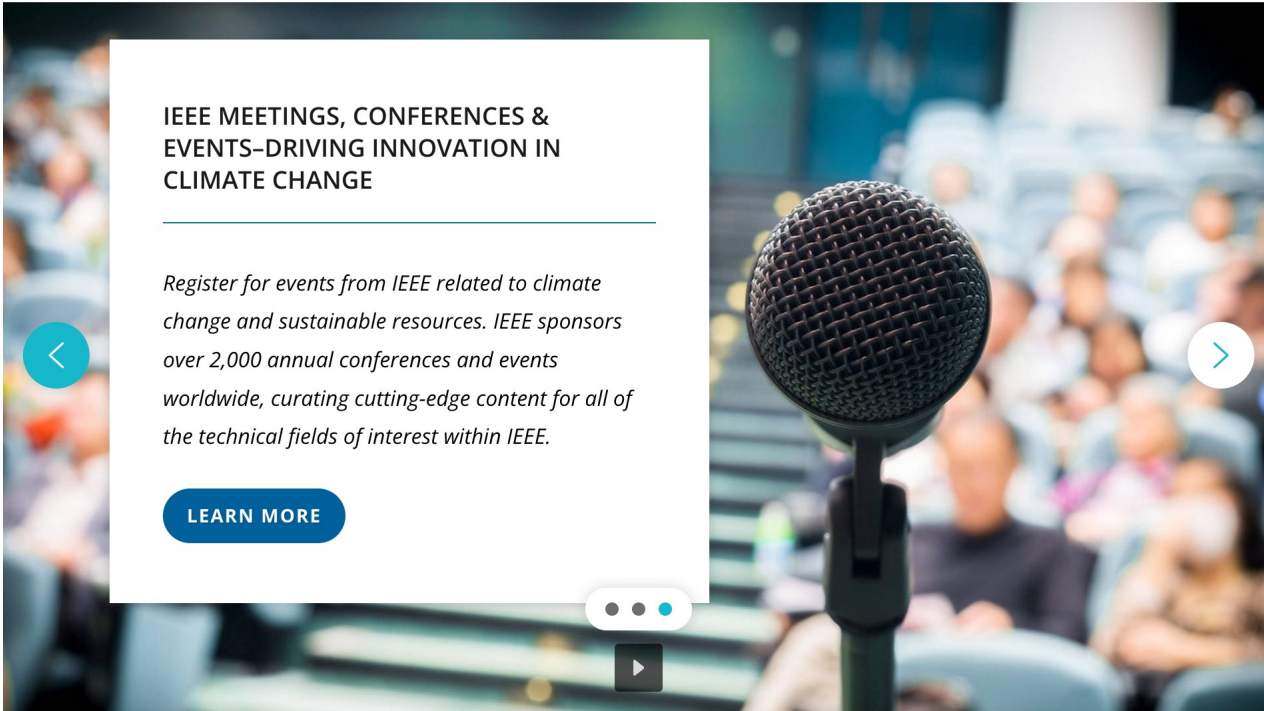
TECHNICAL Solutions	BUILDING Technical Community	CLIMATE CHANGE Mitigation
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email: ccircc@ieee.org

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RESOURCES FROM IEEE

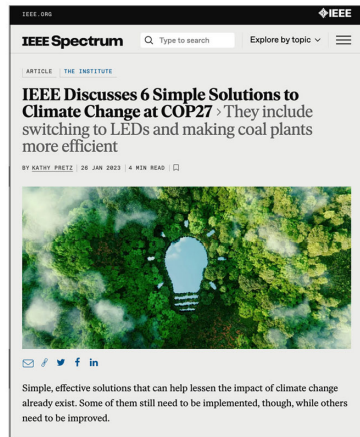
As the world's largest organization of technical professionals, IEEE has both the opportunity and the responsibility to assist in organizing the response of engineers, scientists, and technical professionals across the world to address the causes, mitigate the impact, and adapt to climate change.

IEEE's scholarly publications, conference proceedings, technical standards, and other materials help foster the exchange of technical knowledge and information for the critical climate issues that our planet faces today.

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Ecosystem for IEEE's Climate Sustainability Work

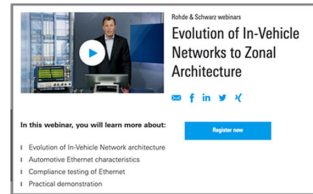
IEEE Spectrum: Climate Change News Feed; Podcasts; Features; Archives; Journal Watch Posts (Xplore); The Institute (Engineers of Climate Change; Coverage of Conferences and Standards)



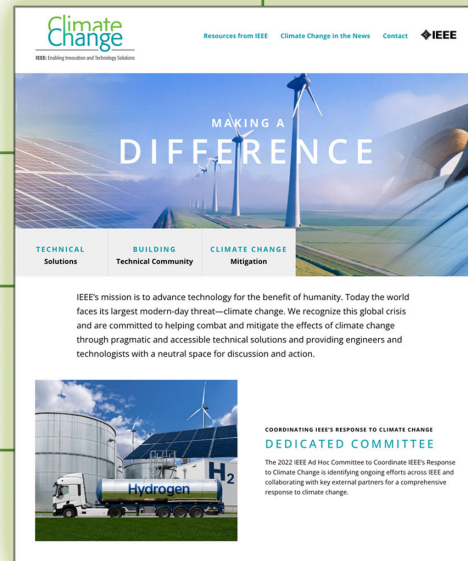
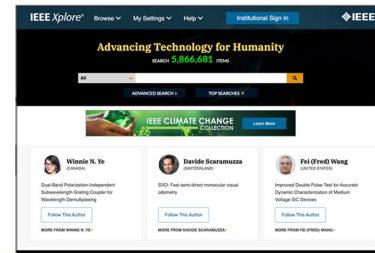
Social Media



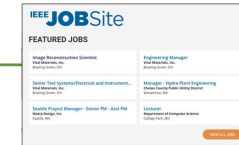
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Xplore: Engineers to Follow; Journal Watch Articles (free); Climate Change Articles



Jobs From IEEE Job Site



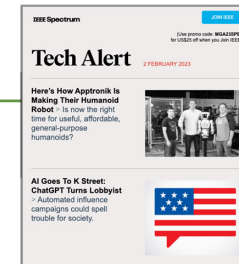
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Registration Open

Early bird registration deadline: **21 July 2023**.
Registration fee increases by **US\$ 50** after that.

Date
11-13 August 2023



Location
Ottawa, Canada

Climate Change Pavilion at SC2023

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