

University of Macao Public Lecture

12 May 2023

**Technologists' Role in Addressing
Climate Sustainability**



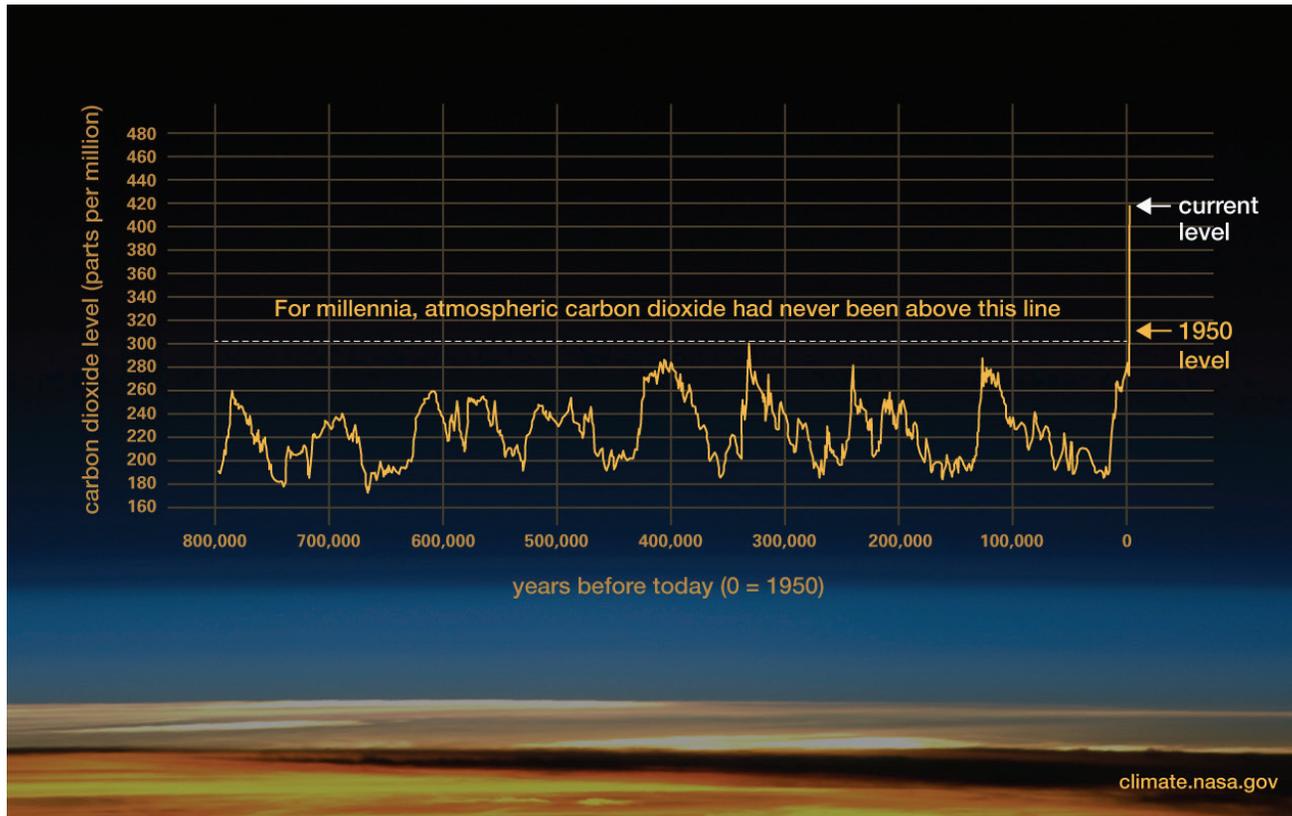
Prof. Saifur Rahman

**IEEE President &
CEO 2023**

**Director, Virginia
Tech Advanced
Research Inst., USA**



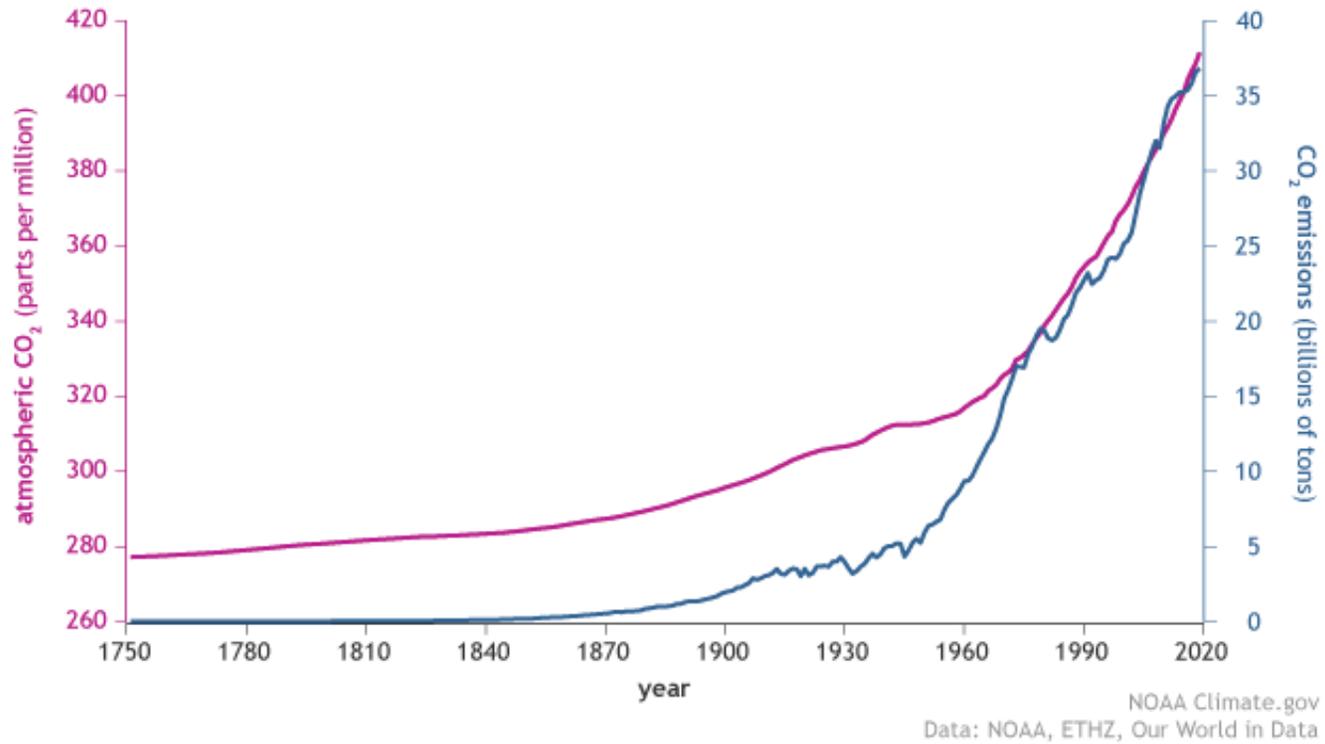
What is Carbonization?



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

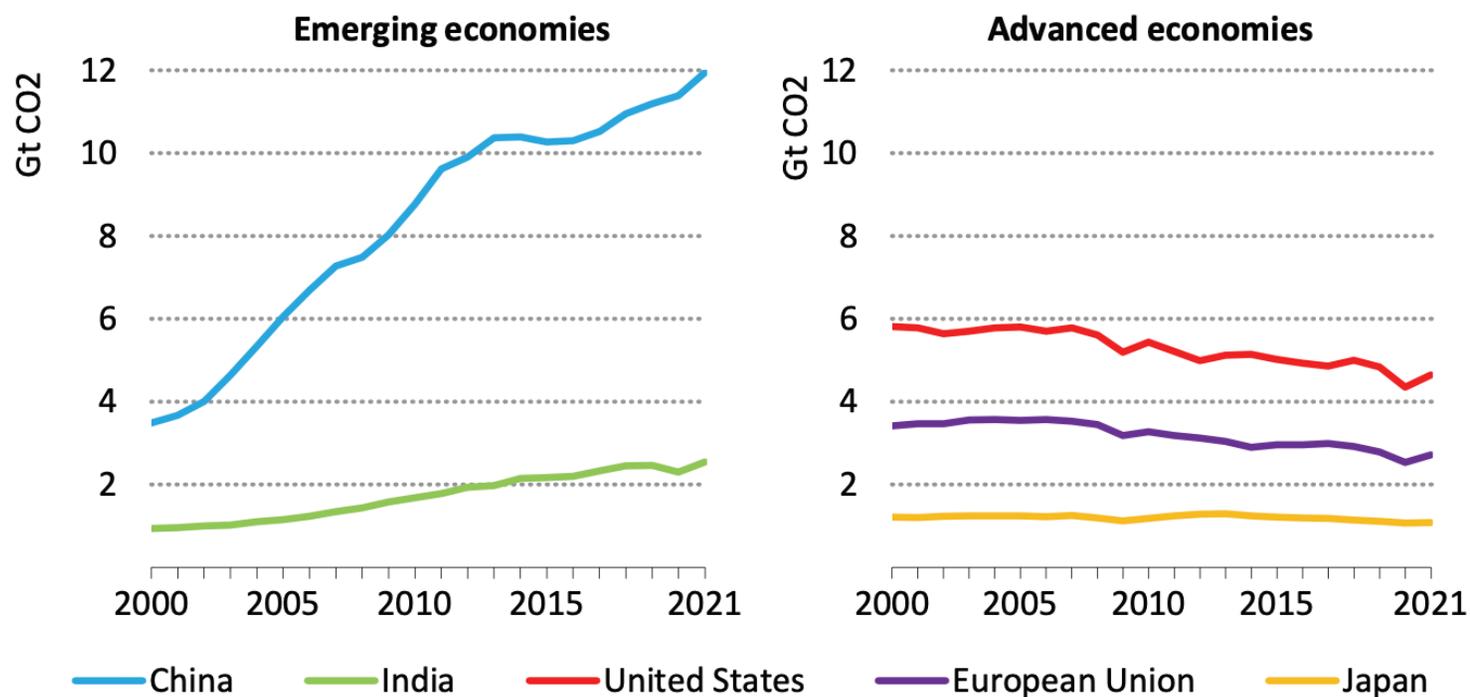
<https://news.climate.columbia.edu/2021/02/25/carbon-dioxide-cause-global-warming/>

Global CO₂ Emissions Due to Fossil Fuel Use in 2021

Coal	15.3 billion tons
Natural Gas	7.5 billion tons
Oil	10.7 billion tons

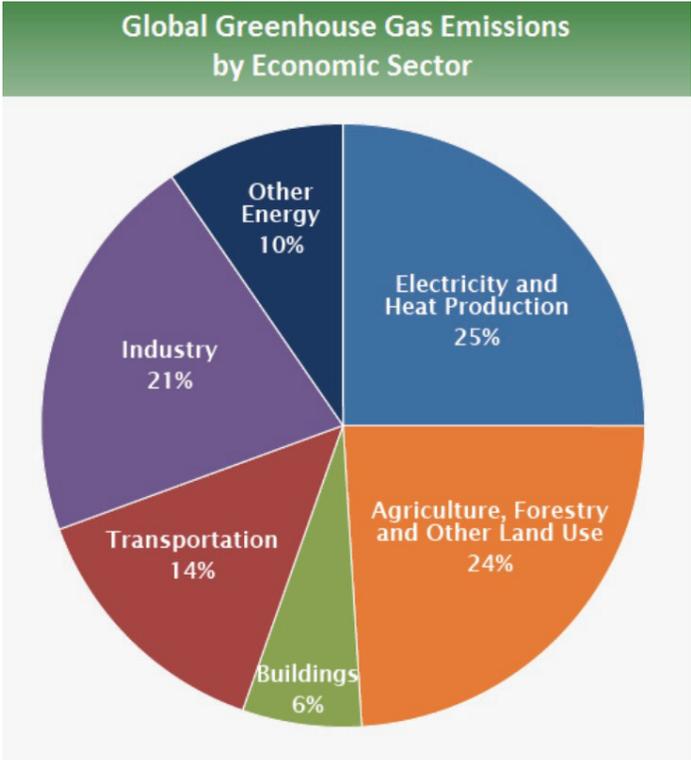
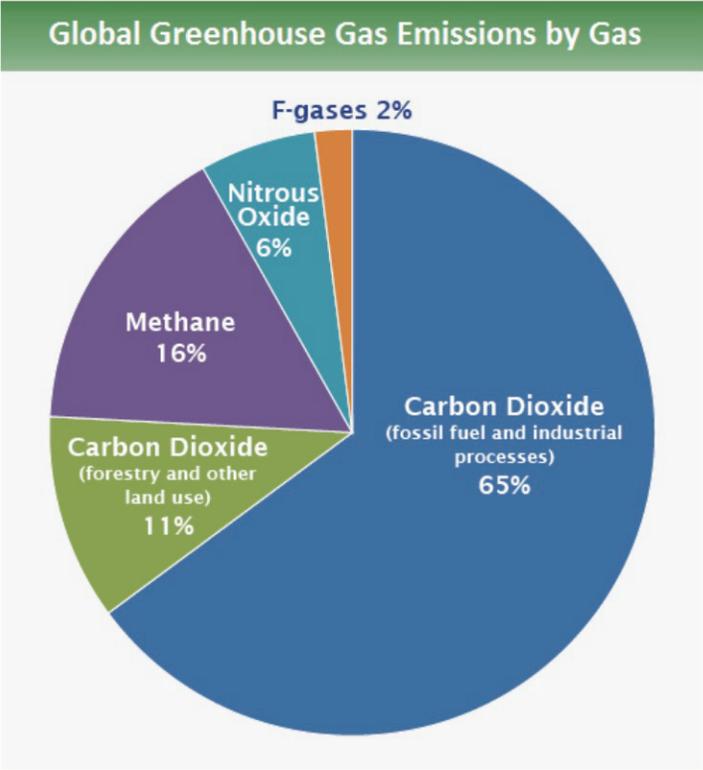
Source: IEA Global Energy Review: CO₂ Emissions in 2021
<https://www.iea.org/reports/global-energy-review-co2-emissions-in-2021-2>

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



IEA. All rights reserved.

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

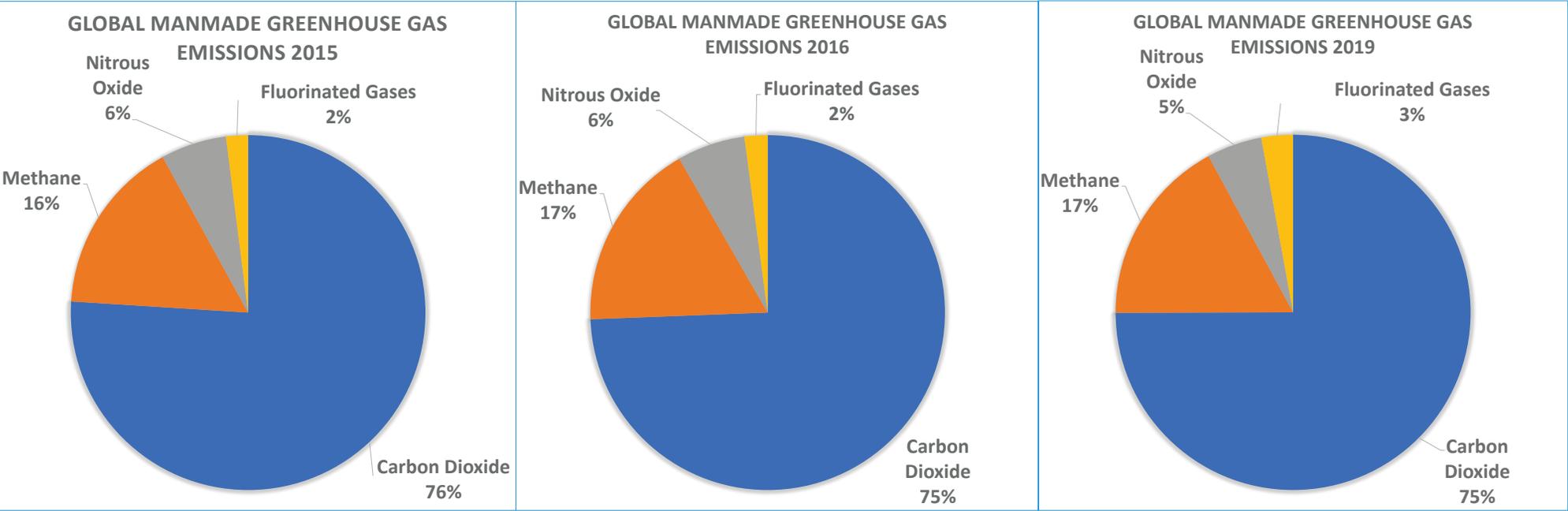


Source: [IPCC \(2014\)](https://www.ipcc.ch/)

<https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>

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

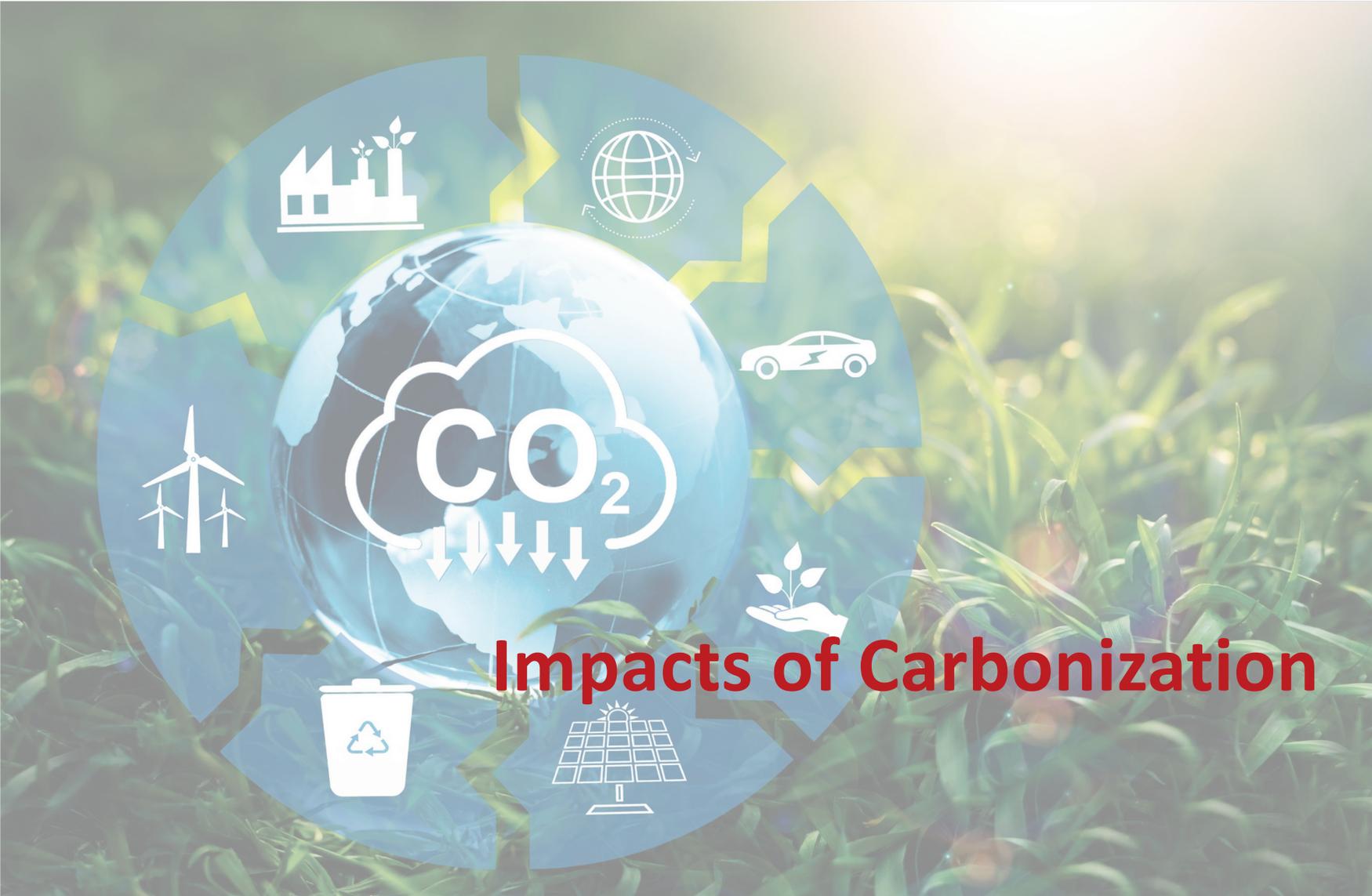
Fluorinated Gases include: HFC, PFC and SF6



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>

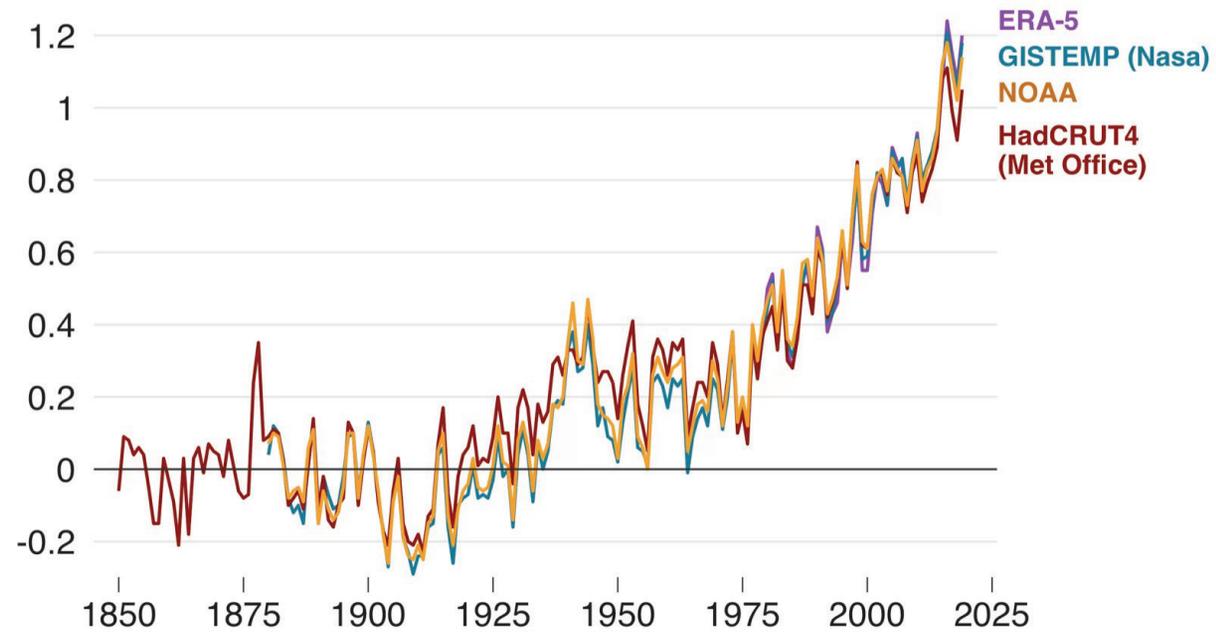
Source: UNEP Emissions Gap Report 2020 <https://www.unep.org/emissions-gap-report-2020>



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>

Africa, China and Florida, USA



Flooding in Pakistan 2022



Source: Stringer/Reuters



Source: AP



Source: Bloomberg

Hurricane Isabel struck the Mid-Atlantic region of the USA between 18-19 September 2003



2023 January Flooding in New Zealand



Aljazeera News, The Waiohiki Bridge is washed away in Napier. [Kerry Marshall/Getty Images]



Flash flood caused by torrential rains in Auckland area in late January 2023

<https://youtu.be/5r2AzhxEvM>

Hurricane Sandy

New York, New Jersey 2012



Droughts in 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 18 August 2022, in Chongqing, **China**

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



<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 13 June 2022, in Flagstaff, **Arizona**.
Rob 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 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



Electrification to Reduce Fossil Fuel Use

Climate
Change

22

IEEE: Enabling Innovation and Technology Solutions



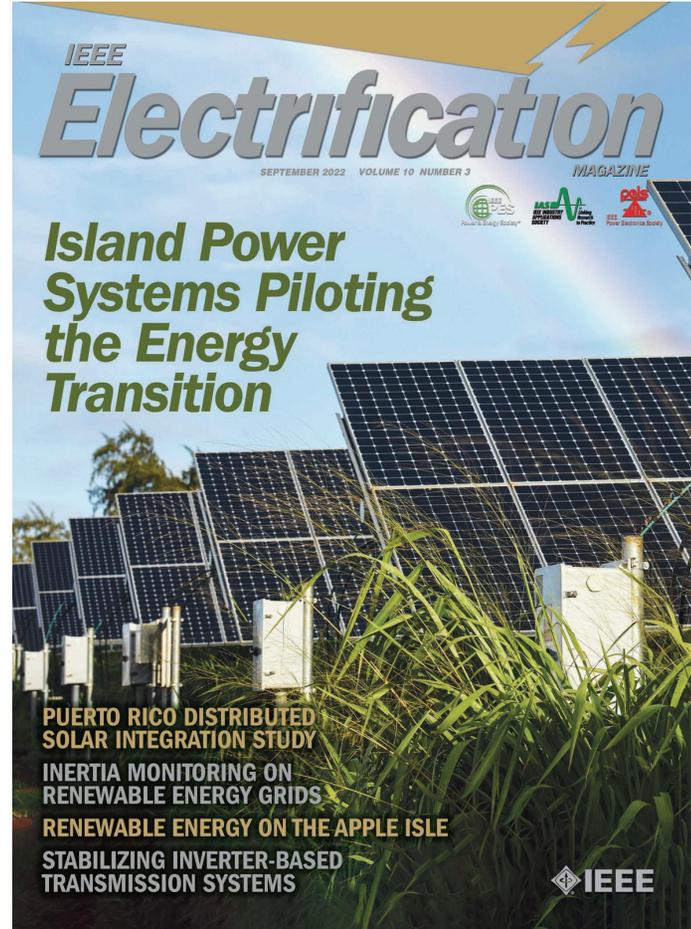
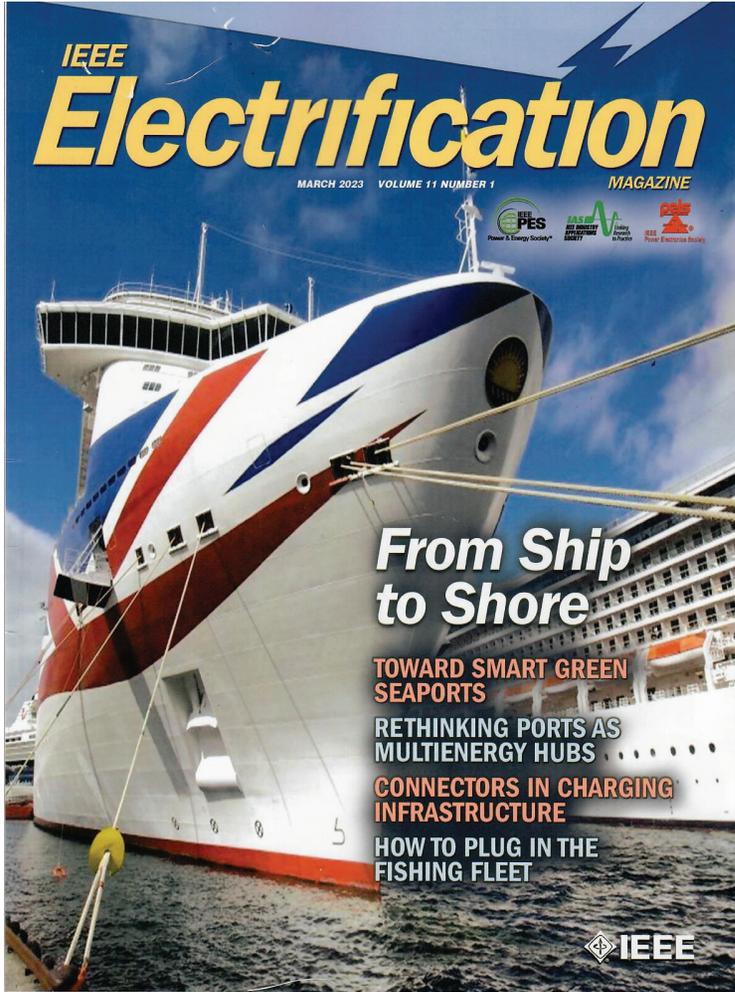
IEEE PROPRIETARY



Electric vehicle



Heat pump as opposed to
oil/gas furnace

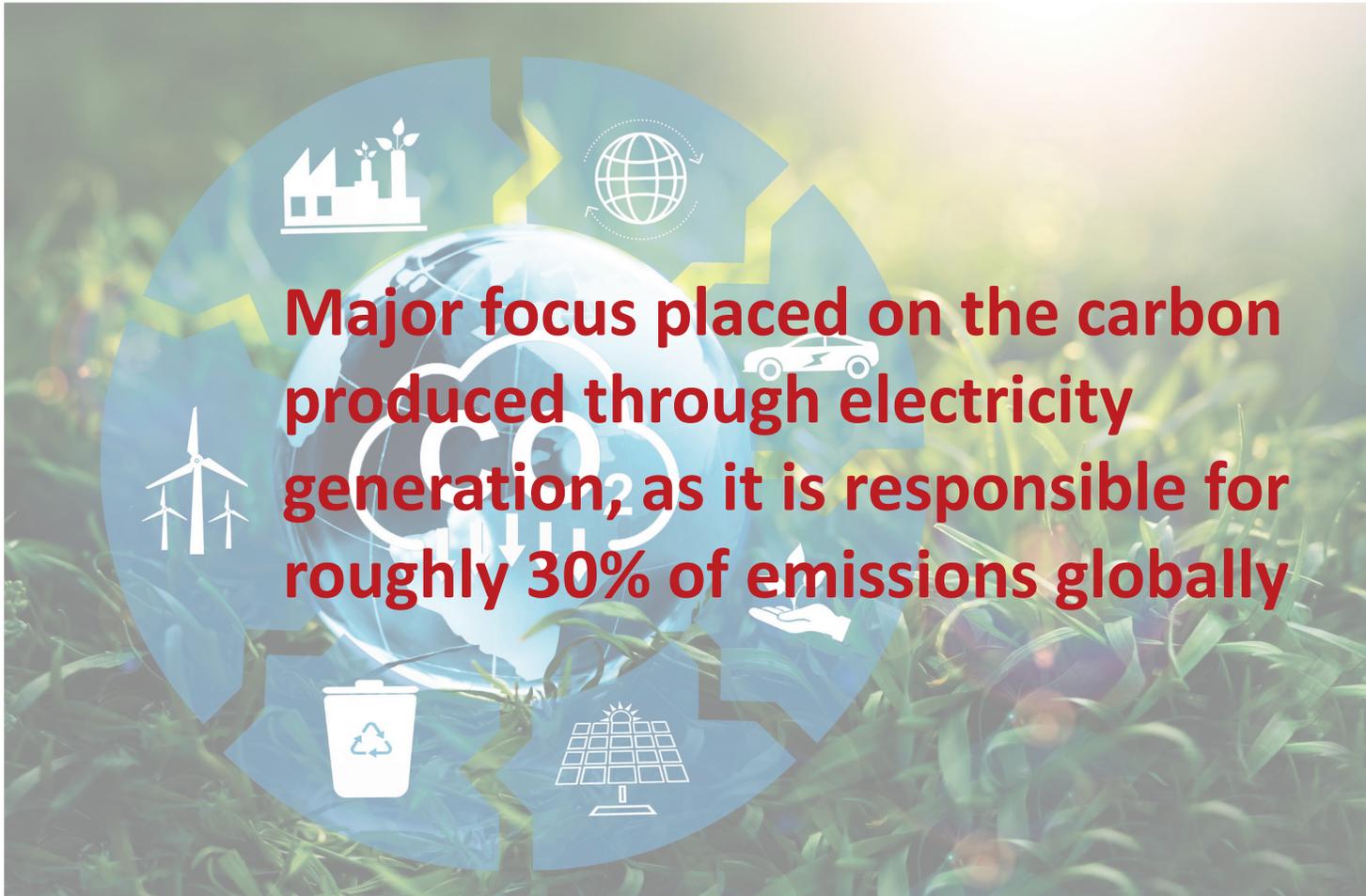


Climate
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Heavy electrification will **double electricity demand in 10-15 years**

We need to rethink how we use, and produce electricity





Climate
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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

Customers Controlling Buildings Optimized for Savings

Measured energy savings across deployments

20% HVAC Energy Savings

25% Lighting Energy Savings

Occupant satisfaction: spaces controlled by a building automation systems are more comfortable due to more consistent temperature profiles and healthier air quality through consistent monitoring of environmental factors (CO₂ levels, PM 2.5).



Hydrogen and Storage Solutions

Optimize renewable energy solutions being integrated into energy grids



- Low-carbon hydrogen will help emerging economies to meet climate goals in and of itself
 - Provide for diverse energy portfolios
 - Improving resilience
 - Lowering costs
- Storage solutions serve as optimizers for other renewable energy solutions
 - Ensure that electricity generated during off-peak hours does not go to waste

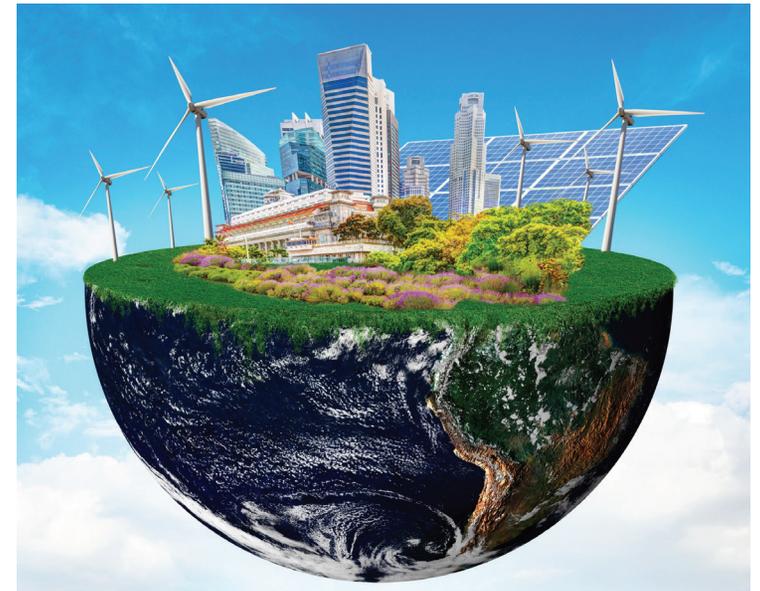


No Transition Without Transmission

Cross-Border Energy Transfer

We all are impacted by climate change

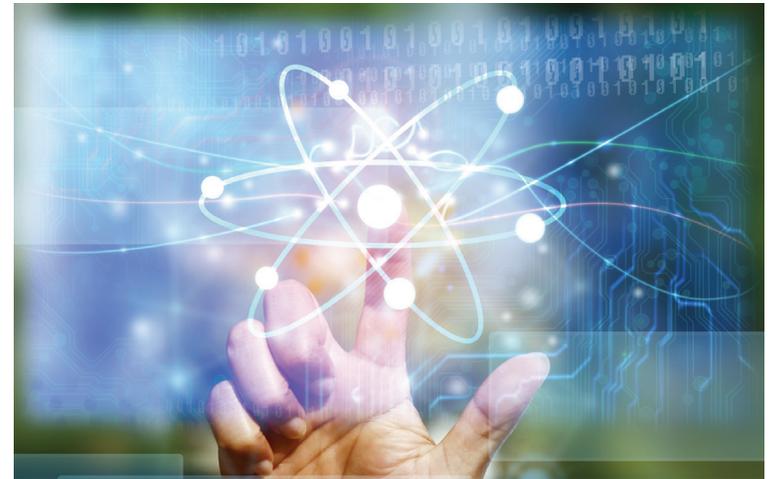
- As we are in this fight together, our solutions should be collaborative to secure better outcomes for all countries, regardless of location
- The International Energy Agency (IEA) has identified three main modes of cross-border energy integration:
 - Bilateral
 - Multilateral
 - Unified



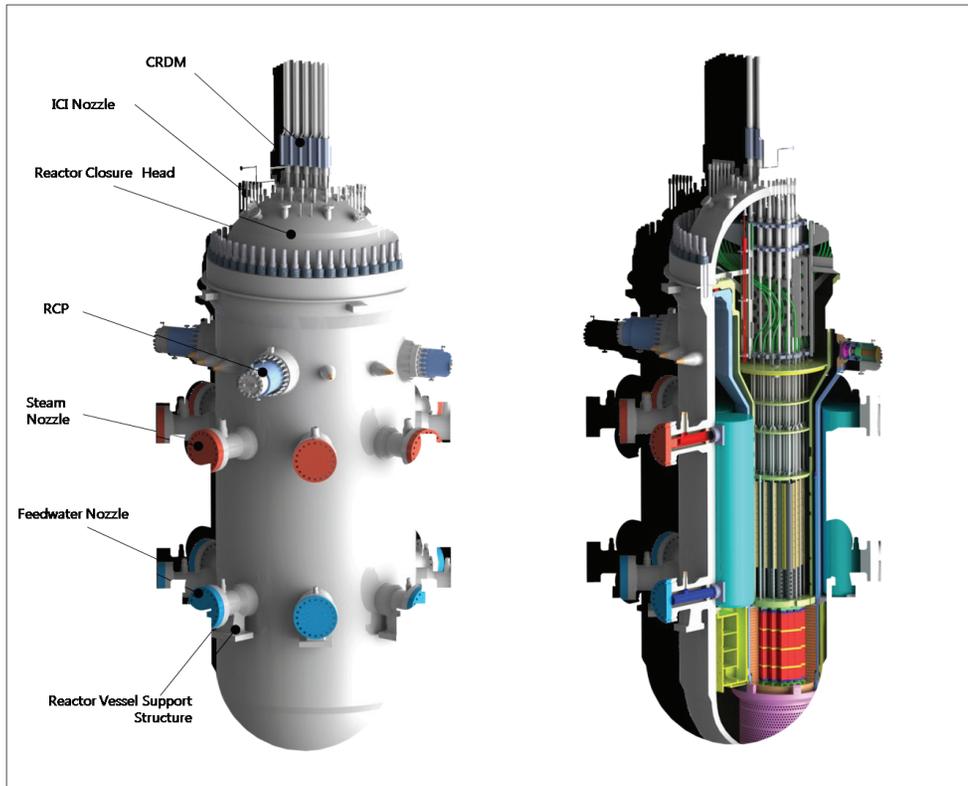
Advanced Nuclear Technologies

Diverse solutions to address climate change

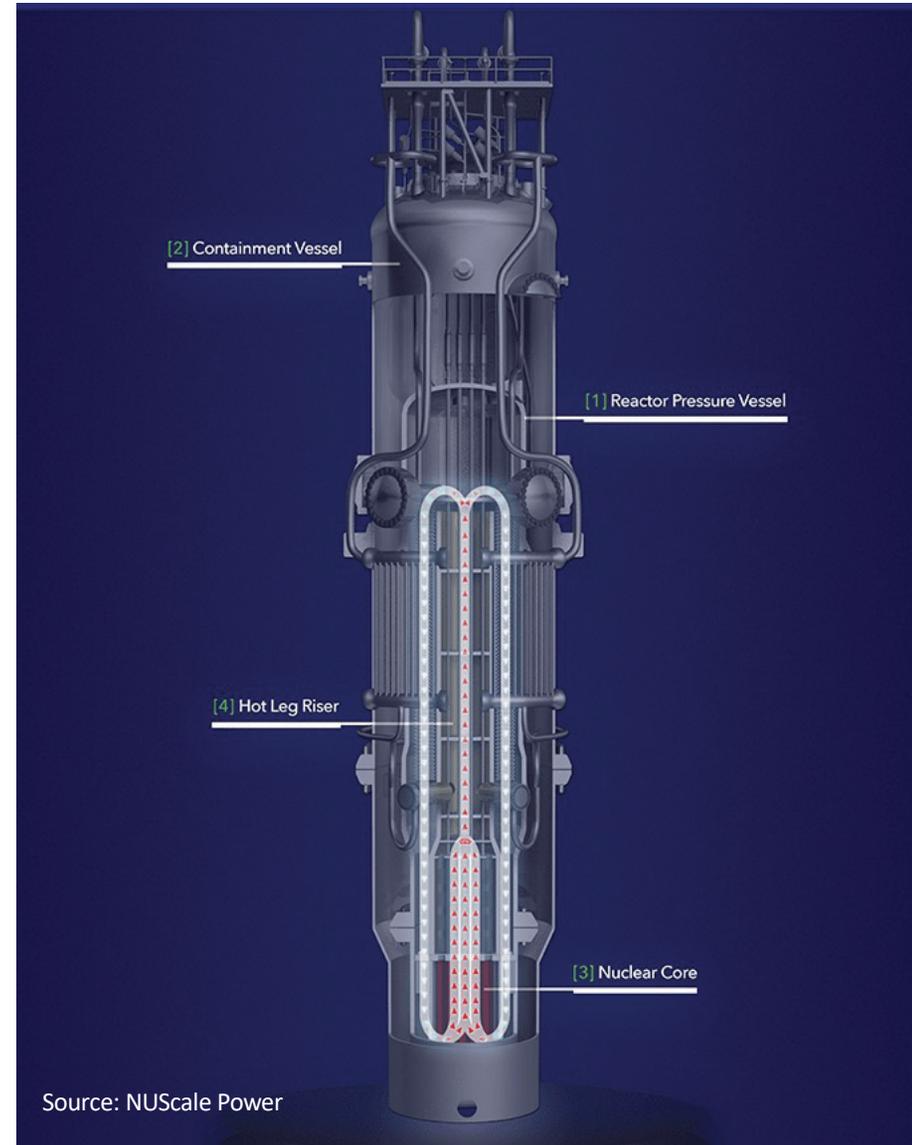
- Advanced nuclear technologies, such as small modular reactors (SMRs), can play a role
 - Smaller and can be built more quickly than more traditional nuclear reactors
- Ramping up the development of SMRs can help to produce energy when and where needed
- This energy could be integrated into existing power grids
 - helping to provide improved resiliency while simultaneously reducing emissions



Small Modular Reactors (SMR)



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



IEEE can be a solution partner

<https://spectrum.ieee.org/6-solutions-to-climate-change>

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IEEE Discusses 6 Simple Solutions to Climate Change at COP27 - IEEE Spectrum

2/6/23, 8:20 AM

IEEE Spectrum

ARTICLE THE INSTITUTE

IEEE Discusses 6 Simple Solutions to Climate Change at COP27 > They include switching to LEDs and making coal plants more efficient

BY KATHY PRETZ 26 JAN 2023

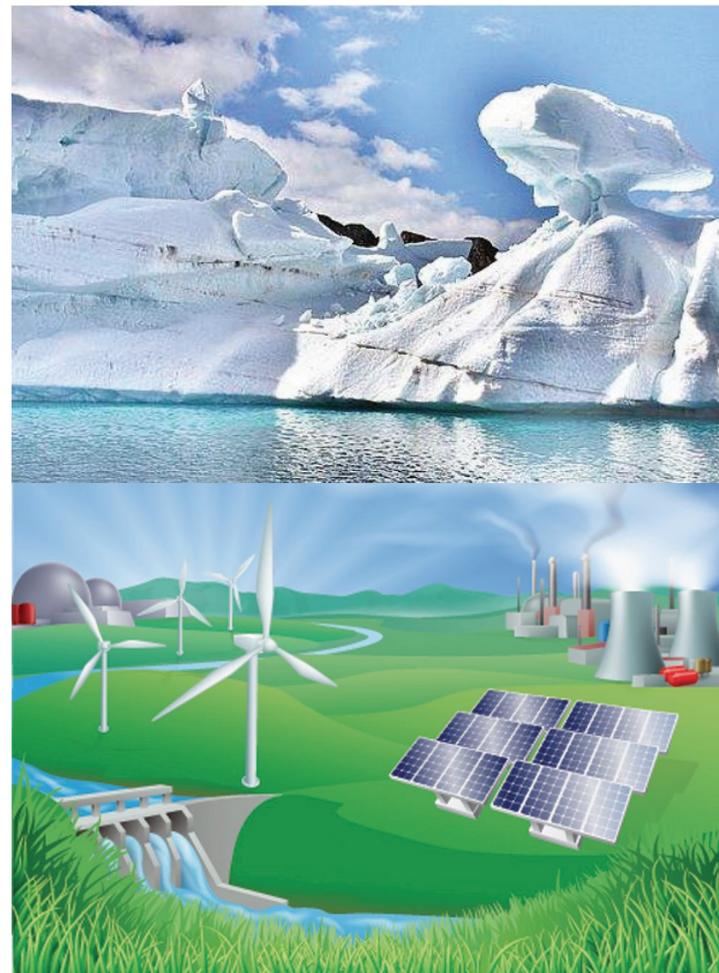


<https://spectrum.ieee.org/6-solutions-to-climate-change>

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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



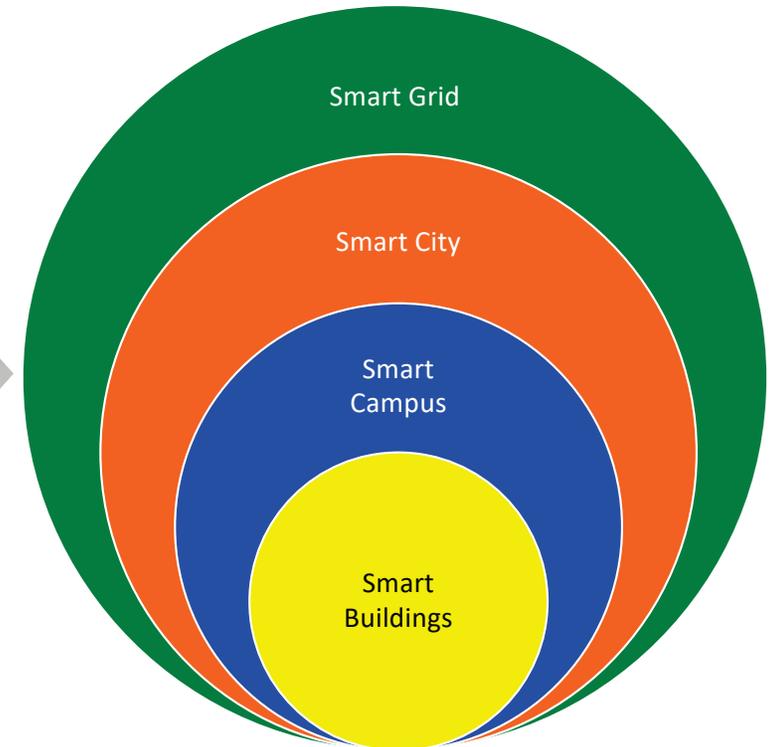
The Smart Grid Ecosystem

Smart grid: Bi-directional flows of energy, remote control/automation of power, integrated distributed energy...

Smart city: Complex system of interconnected infrastructures and services...

Smart Campus: A collection of buildings managed by the same facility manager...

Smart buildings: Intelligent building automation systems, smart devices, productive users, grid integration...



← Supported by ICT and distributed networks of intelligent sensors, data centers/clouds →

(c) Saifur Rahman

IEEE's Climate Change Program

Climate Change

IEEE: Enabling Innovation and Technology Solutions





*Advancing Technology
for Humanity*

What Can you Do to Serve Humanity?

Clean Tech Solutions for Climate Change.

IEEE's Presence in the UN Conference on Climate Change (COP27) Egypt November 2022

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IEEE at UN Climate Change Conference



Partnership with International Renewable Energy Agency (IRENA)

Founding Partners: Energy Transition Education Network

ETEN Founding Partners

Convened by:  **IRENA**
International Renewable Energy Agency

Partners:  **unesco**

Teach For All
A Global Network

 **for every child**

 **Higher Education Sustainability Initiative**

HESI+10
Celebrating 10 years with Higher Education Sustainability Impact

 **IEEE**
Advancing Technology for Humanity

 **ENERGY TRANSITION EDUCATION NETWORK**

 **IRENA at COP27**

PERMANENT MISSION OF THE UNITED ARAB EMIRATES INTERNATIONAL RENEWABLE ENERGY AGENCY (IRENA)  البعثة الدائمة الإمارات العربية المتحدة الوكالة الدولية للطاقة المتجددة (إيرينا)

COP27 Event by IRENA

Energy Transition Education Network



Ongoing Climate Change Related Activities Across IEEE



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IEEE Climate Change Website

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

Climate Change
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Resources from IEEE Climate Change in the News Contact **IEEE**

MAKING A
DIFFERENCE

TECHNICAL
Solutions

BUILDING
Technical Community

CLIMATE CHANGE
Mitigation

Email: ccircc@ieee.org



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.

[View the IEEE Climate Change Collection in IEEE Xplore®](#)



IEEE Sections Congress 2023

The triennial gathering of Section leadership bringing together hundreds of delegates from all ten Regions to network, learn and collectively shape the future of IEEE.

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

THANK YOU!

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