

Powering Change:
Clean Energy Pathways & The Role of Engineers

Keynote Speech, IEEE PES R10 SCC Webinar

Professor Saifur Rahman, IEEE Life Fellow
2023 IEEE President
17 November 2026

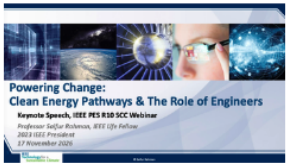
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Date	Recent and Upcoming Presentations and Webinars	Webinar/Presentation Slides
17 November 2026 ***R10 SCC Webinar***	**Powering Change: Clean Energy Pathways & The Role of Engineers** Keynote Speech, IEEE PES R10 Students Chapter Committee Webinar This lecture explains what carbonization is, addresses its causes and impacts. It then offers technological solutions to reduce CO2 emissions from the electric power sector which is responsible over 30% of global Carbon emissions. In order to address the reduction of carbon emissions from the electric power sector, a collaborative approach between the industrialized nation states and emerging economies is necessary. This will involve a portfolio of solutions with low-carbon generation from wind, solar, hydro and nuclear, storage, cross-border power transfer and advanced technology focusing on energy efficiency. This talk also discusses the IEEE Climate Change program and related activities. Saifur Rahman, PhD Joseph Loring Professor of Electrical Engineering and Director, Virginia Tech Advanced Research Institute, USA 2023 IEEE President	

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Carbonization is Challenging Climate Sustainability







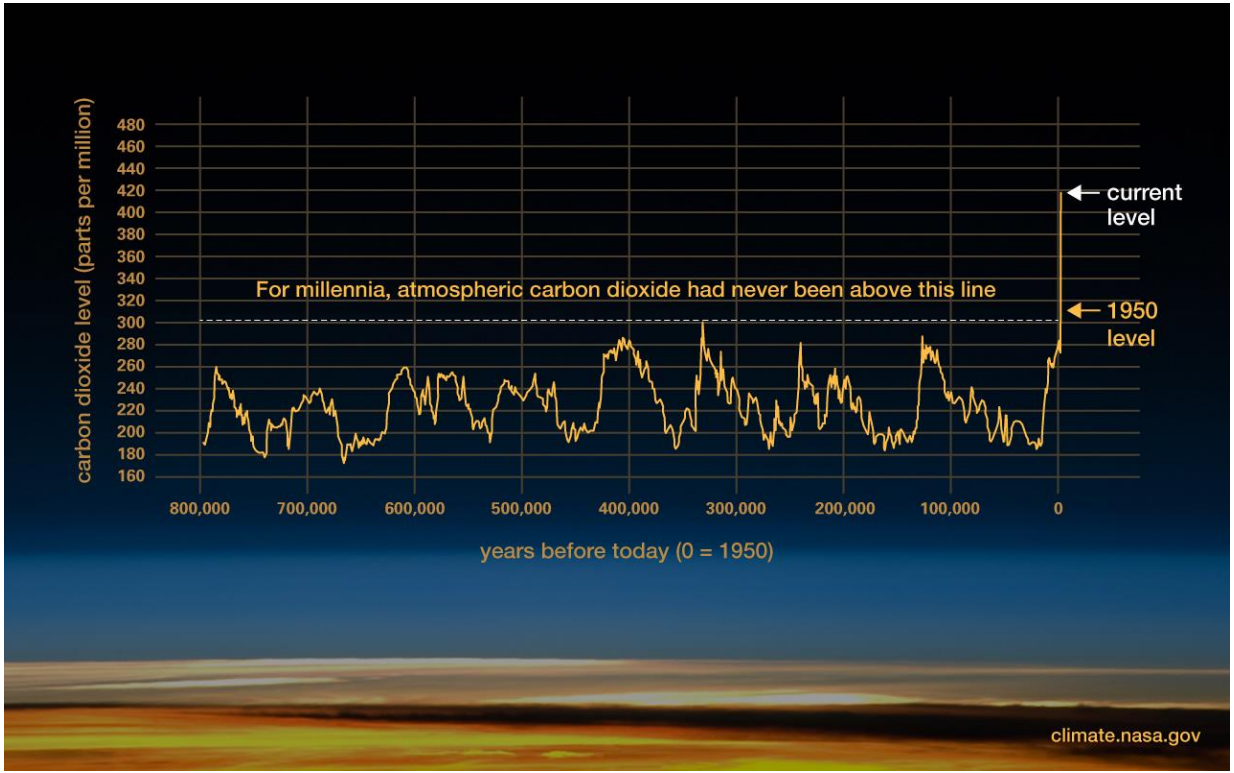
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What is Carbonization?

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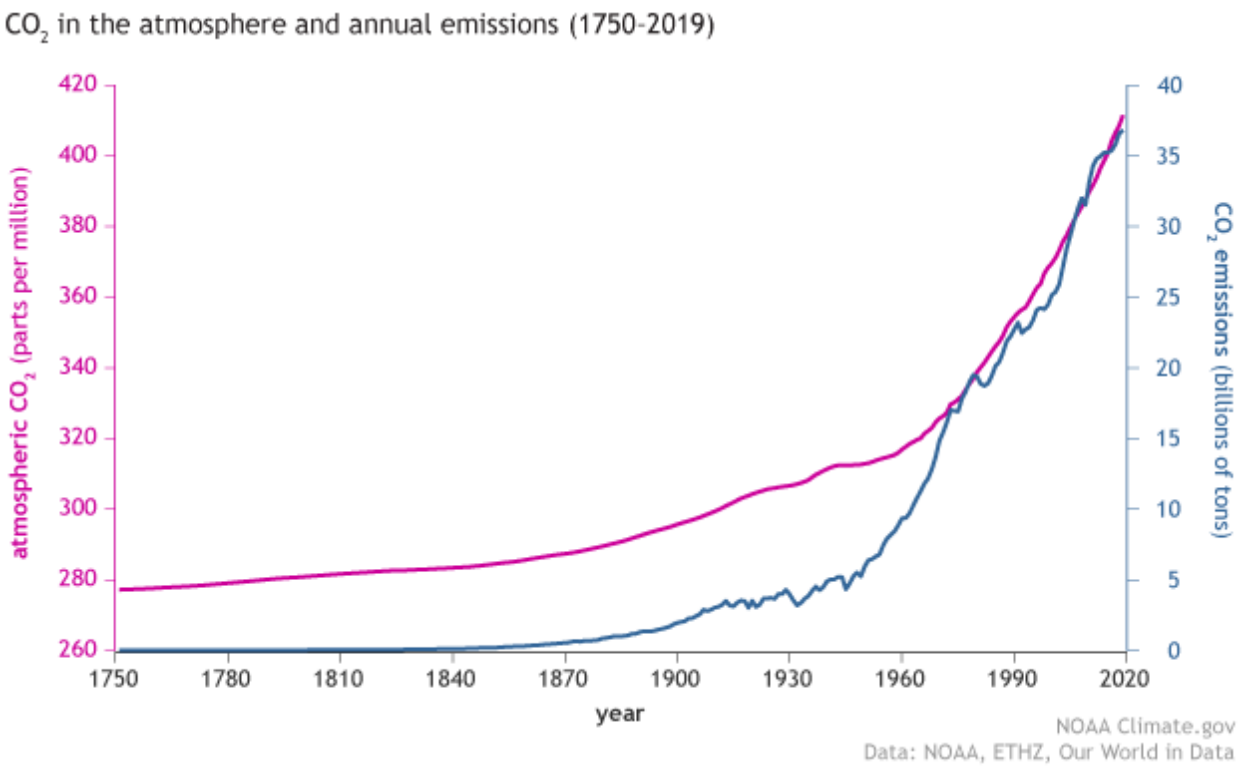
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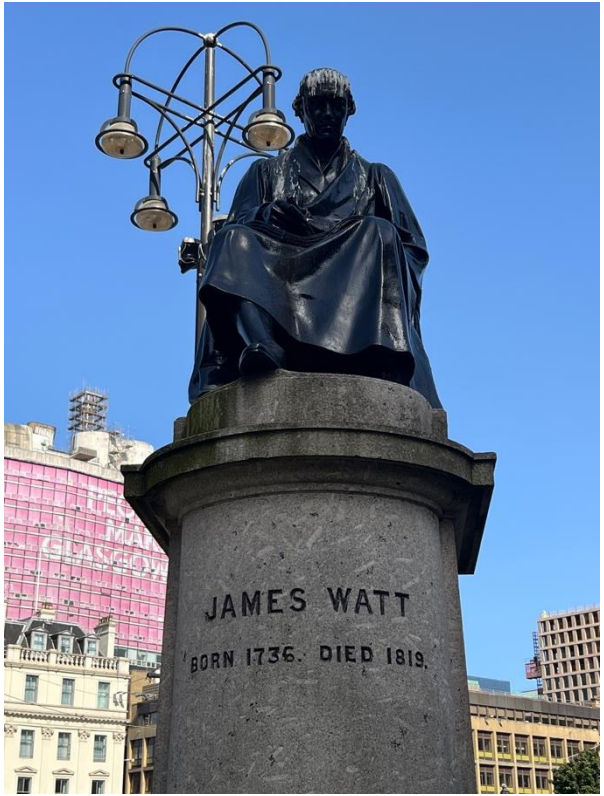


Source: NASA
https://climate.nasa.gov/climate_resources/24/graphic-the-relentless-rise-of-carbon-dioxide/

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Source: State of the Planet
https://news.climate.columbia.edu/2021/02/25/carbon-dioxide-cause-global-warming/

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Impacts of Carbonization

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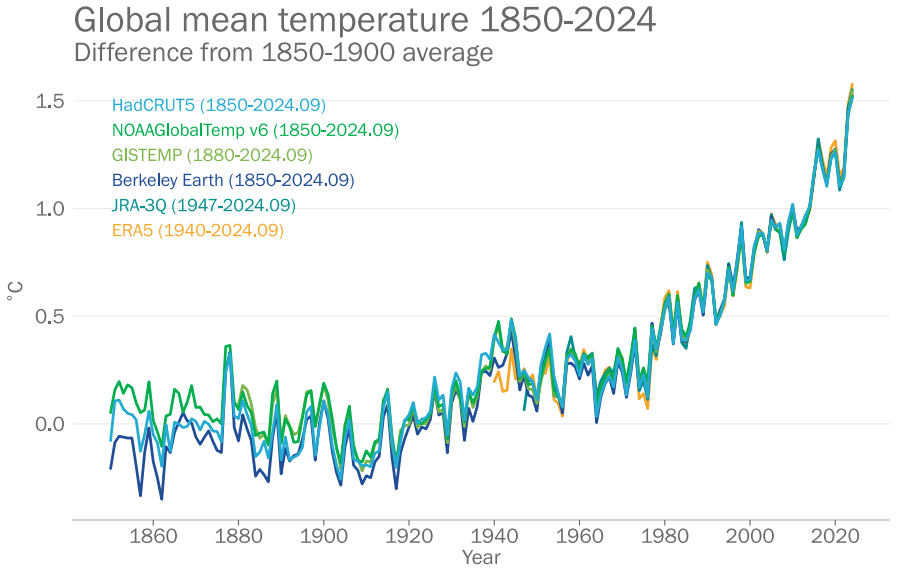
Global mean temperature
2024 was the warmest year on record

Global mean temperature
January-September 2024
1.54±0.13°C

Note that a single year above 1.5 °C does not mean that we have passed the warming levels in the Paris Agreement

On track to be the warmest year in all six datasets

The past 10 years 2015-2024 are the 10 warmest years on record



Source: World Meteorological Organization

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Climate-change Impacts









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The Palisades Fire tears through a neighborhood in Pacific Palisades, Los Angeles, driven by strong winds on Tuesday, Jan. 7, 2025.
Source: https://apnews.com/article/los-angeles-wind-wildfires-climate-change-weather-42b55ae1e66b56a6375300e448f01946

Fire in Los Angeles

January 2025

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A beach house is engulfed in flames as the Palisades Fire burns along Pacific Coast Highway in Malibu, Calif., on Jan. 8, 2025.
Source: https://abcnews.go.com/US/worst-fire-pacific-palisades-experts/story?id=117507457
Agustin Paullier/AFP via Getty Images

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Flooding in Bangladesh – August 2024









Heat Wave in Delhi – May 2024









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Flooding in Spain in 2024





Source: National Public Radio, USA

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Flooding in Greece in 2023



A vehicle crosses a flooded road in the city of Volos, central Greece (AFP via Getty Images) Sept 2023



Cars in a flooded road in the city of Volos, central Greece (AFP via Getty Images) Sept 2023

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Droughts in 2022



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

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



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/

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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

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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

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CO2 is the Primary Driver for Climate Change

Sources of CO2 emissions

- Transportation: 40%
- Electricity Generation: 30%
- Industry and Buildings: 30%

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Technologies to Reduce Carbon Emissions in the Electricity Sector



Focus on the Electricity Sector

1. Use less electricity, energy efficiency
2. Use low carbon fossil fuel power plants
3. Use H_2 & other storage technologies
4. Promote more renewables
5. Accept some nuclear
6. Promote cross-border power transfer

Controlling Building Operations Optimized for Savings

Energy savings from air conditioning control: 10-15%

Energy savings from lighting control: 15-20%





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Energy Efficiency Applications

Consider light bulbs

- Provide more energy efficient applications and tools globally

- The amount of electricity required to run an LED light bulb is less than 15% of what is needed to run an incandescent light bulb producing the same amount of light



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Highly Efficient Fossil-fuel Power Plants



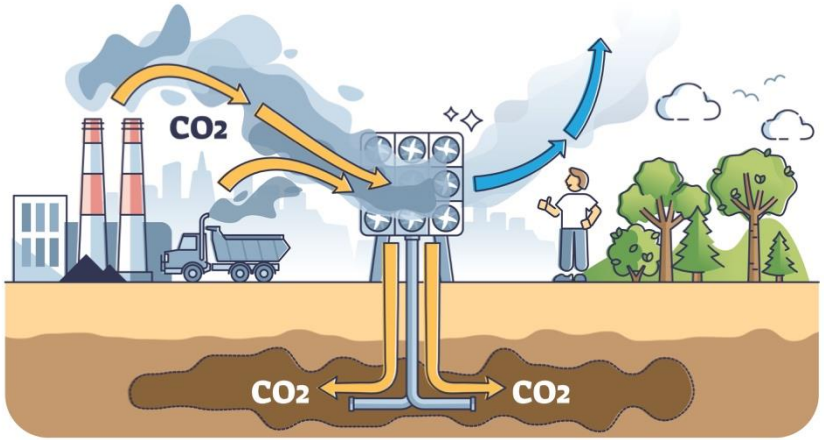
- Combined Cycle Gas/Steam Power Plant
- Ultra-supercritical steam power plant

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Carbon Capture & Storage Systems (CCS)

- Direct Air Capture (DAC) can help ensure that emissions created during the energy generation phase will not be emitted into the atmosphere
- These technologies have the potential to significantly reduce carbon emissions in energy systems across the board



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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

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Renewable Energy Integration

Whitelee Windfarm, Glasgow, Scotland



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Kenya School of Monetary Studies, Nairobi





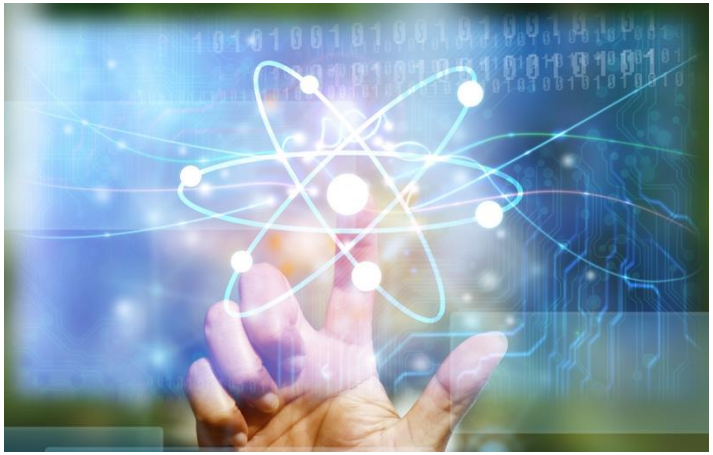
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Advanced Nuclear Technologies

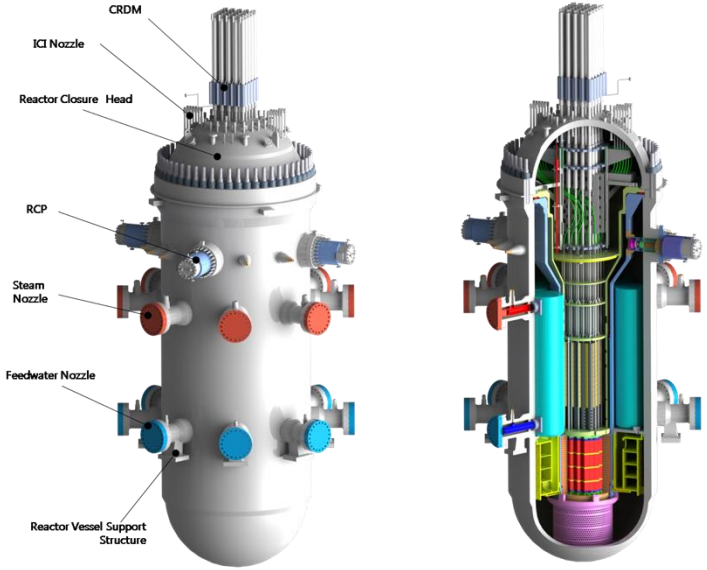
Diverse solutions to address climate change

- 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

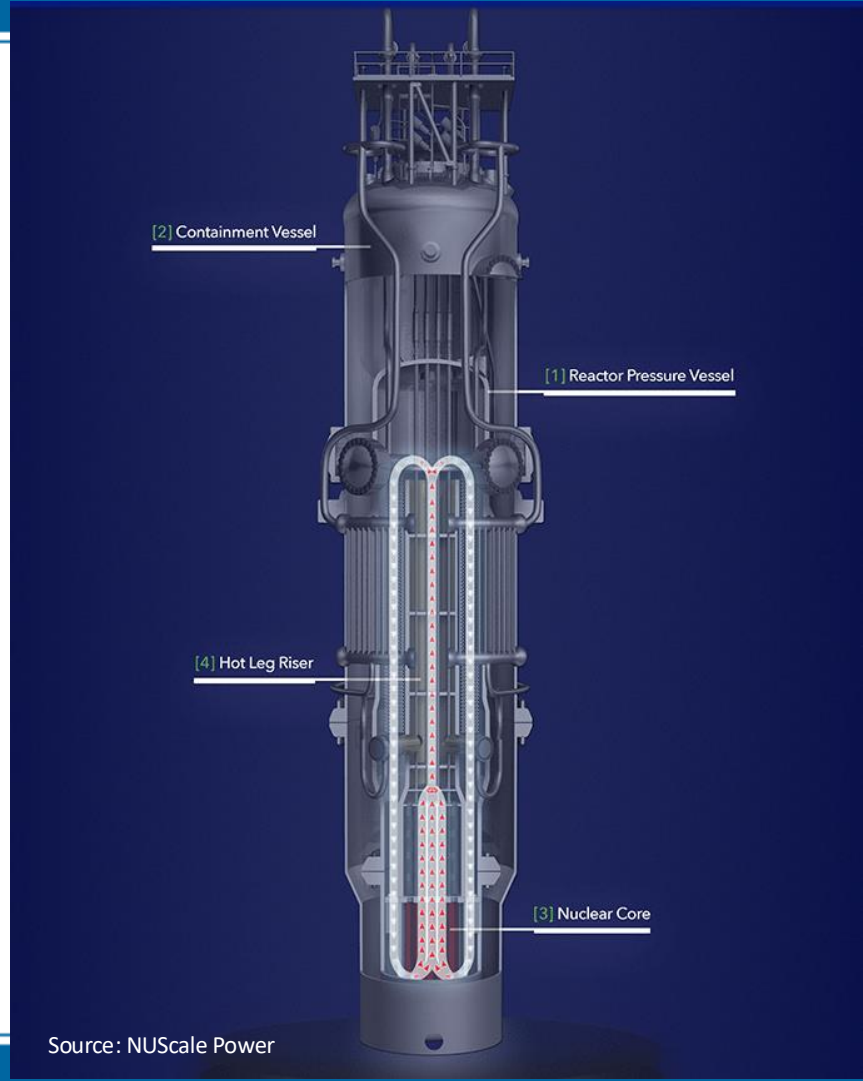


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Small Modular Reactors (SMR)



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



Source: NUScale Power

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Cross-Border Energy Transfer

No Transition without Transmission

- 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



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Advancing Technology for Humanity

What Can you Do to Serve Humanity?

Clean-Tech Solutions for Climate Sustainability

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Climate Change

IEEE: Enabling Innovation and Technology Solutions

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IEEE's Climate Change Program

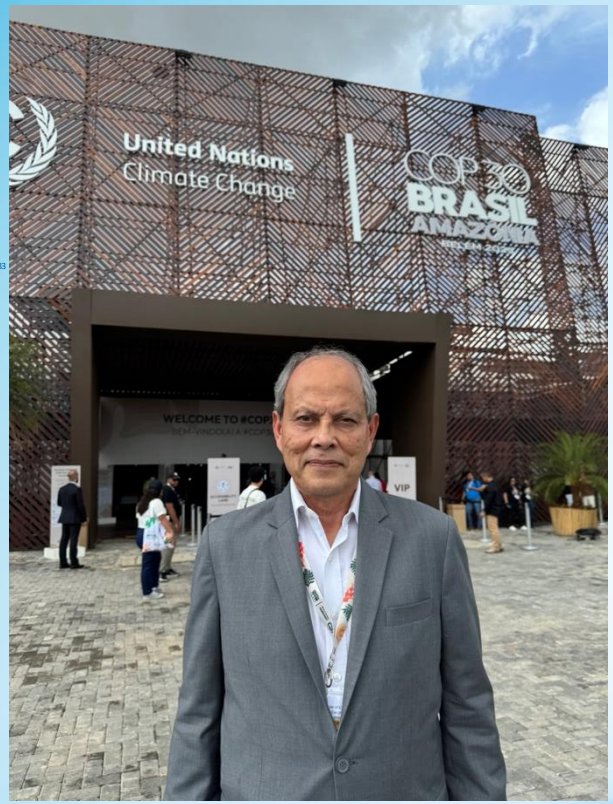


IEEE: Enabling Innovation and Technology Solutions

https://sustainable-climate.ieee.org

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IEEE at UN Conference on Climate Change

Belem, Brazil, November 2025, COP30

https://cop30.br

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Talk at the IYNC Pavilion, COP30, Brazil





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Strengthening Capacity Building for Energy Transition, COP30, Brazil

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IEEE-ITU Symposium on Achieving a Resilience Climate

Geneva, 12-13 December 2024



Photo credit: ITU

https://isasc.ieee.org

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IEEE-ITU Symposium on Achieving a Resilience Climate

Geneva, 15-16 December 2025



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IEEE-ITU Symposium Opening Speech

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IEEE Climate Magazine a new open access publication dedicated to the application of technology to climate change.

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Thank You

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