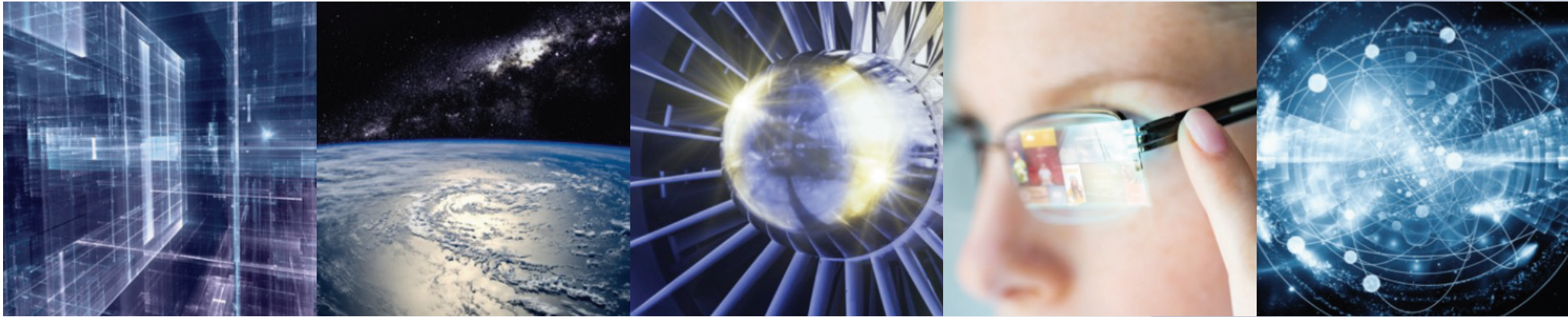




Role of Technology in Achieving a Sustainable Climate

Invited Talk

Tsinghua University Colloquium

Professor Saifur Rahman, IEEE Life Fellow

Director, Virginia Tech Advanced Research Inst.

2023 IEEE President

10 Sep 2025





PPT slides are available at
www.srahman.org



Saifur Rahman

2023 IEEE President and CEO

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10 September 2025

Beijing, China

Role of Technology in Achieving Climate Resilience

Invited Talk, Tsinghua University Colloquium

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

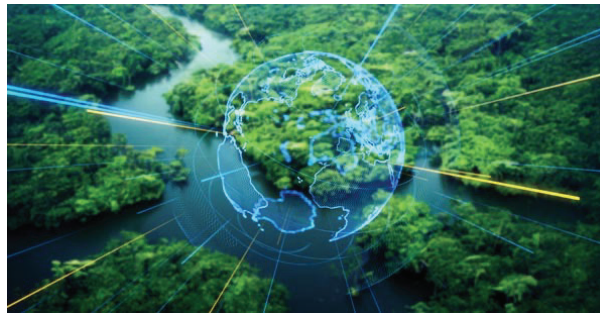
Joseph Loring Professor of Electrical Engineering and Director

Virginia Tech Advanced Research Institute, USA

IEEE President 2023



Carbonization is Challenging Climate Sustainability



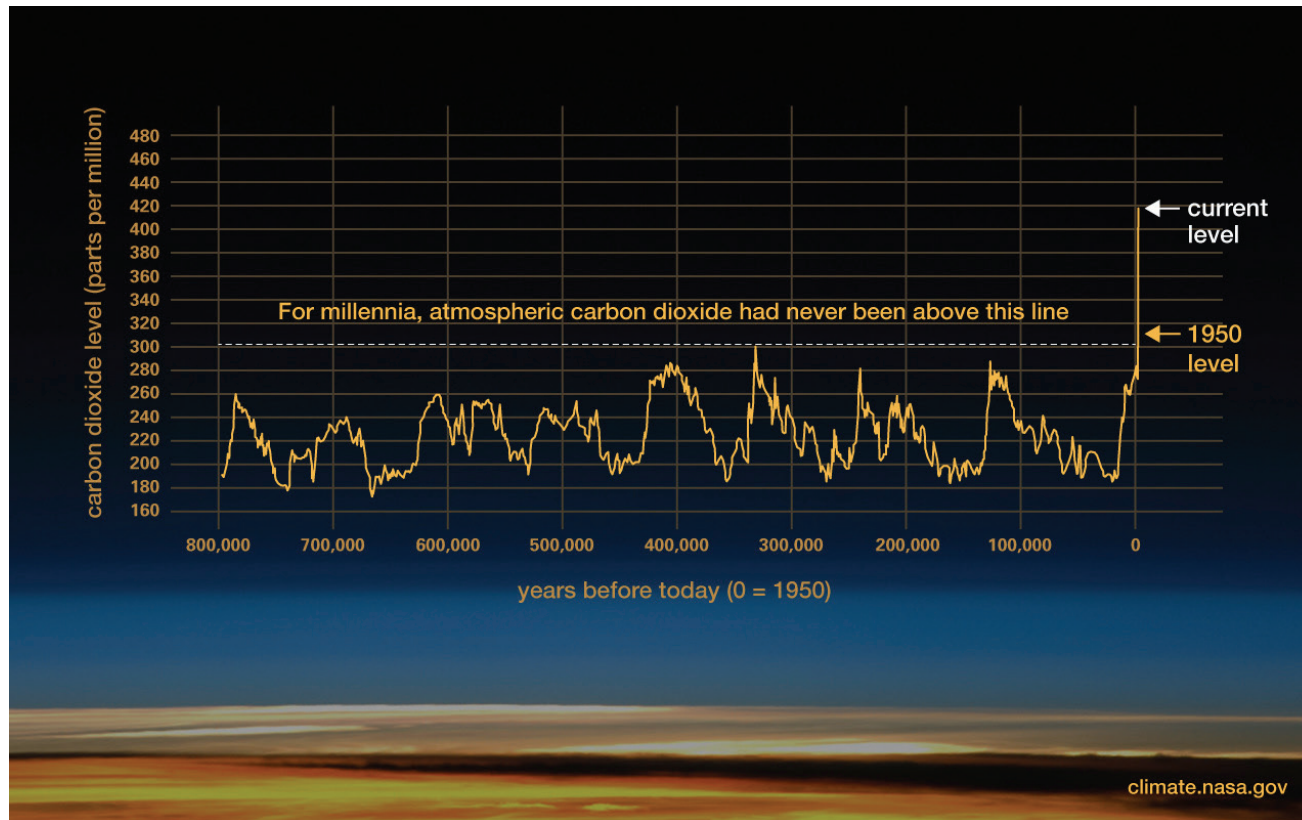
Climate
Change

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IEEE: Enabling Innovation and Technology Solutions



What is Carbonization?

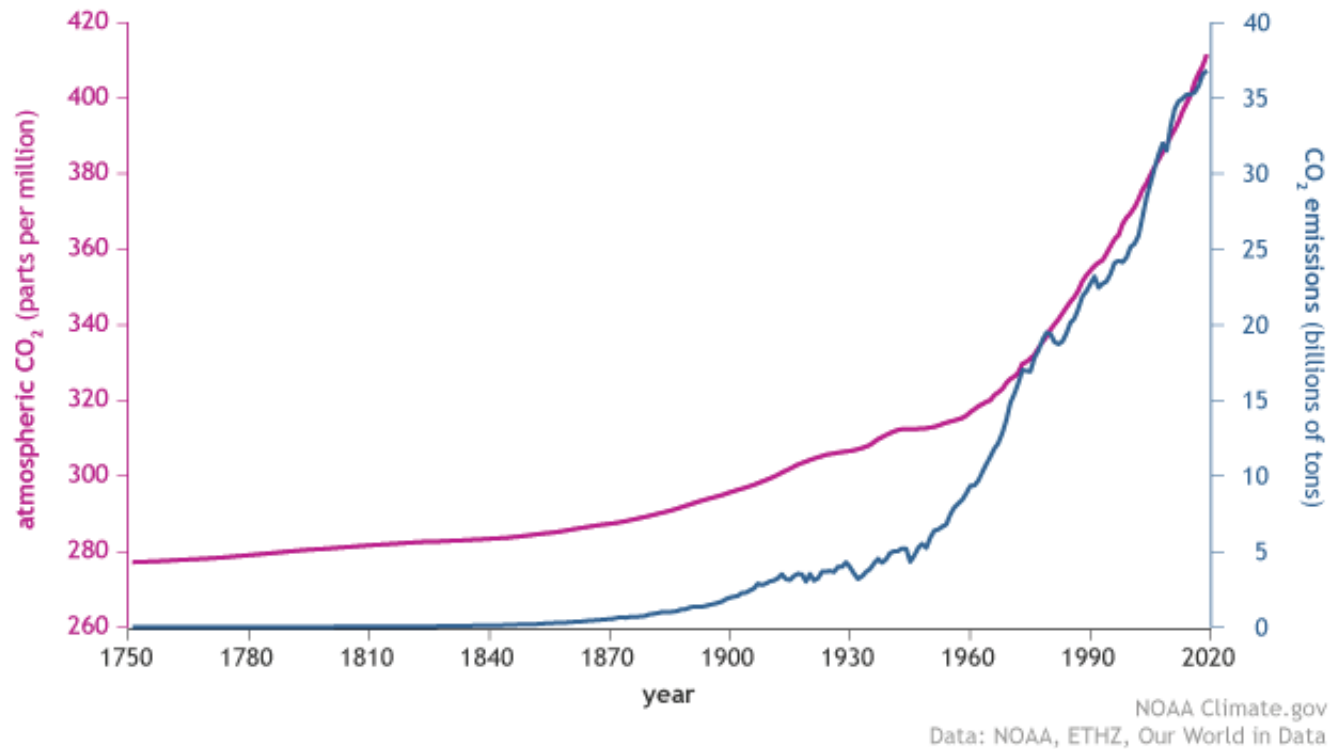


Source: NASA

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

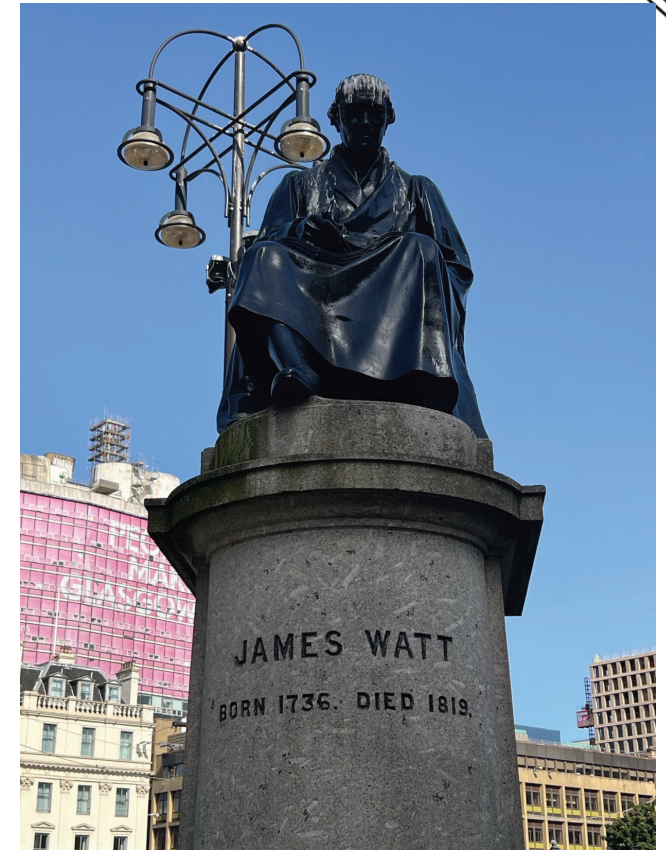


CO₂ in the atmosphere and annual emissions (1750-2019)



Source: State of the Planet

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



Impacts of Carbonization

Global mean temperature 2024 was the warmest year on record

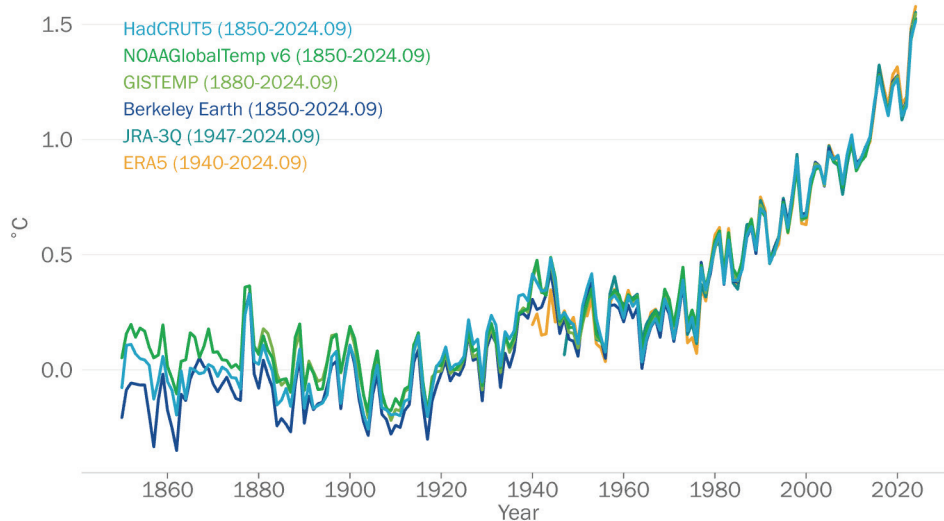
Global mean temperature
January-September 2024
 $1.54 \pm 0.13^\circ\text{C}$

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

Global mean temperature 1850-2024
Difference from 1850-1900 average



Source: World Meteorological Organization



State of Global Water Resources

- ▶ 2023 marked the driest year for global rivers in over three decades.
- ▶ Highly elevated temperatures in 2023 and 2024 with widespread dry conditions contributed to prolonged droughts.
- ▶ Hydrological cycle has accelerated and become more erratic and unpredictable.
- ▶ 3.6 billion people face inadequate access to water at least a month per year and this is expected to increase to more than 5 billion.



Climate-change Impacts



Vehicles are stranded after a heavy downpour in Zhengzhou city, central China's Henan province on Tuesday, July 20, 2021. Heavy flooding has hit central China following unusually heavy rains, with the subway system in the city of Zhengzhou inundated with rushing water. (Chinatopix Via AP)

The Associated Press





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



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



Flooding in Bangladesh – August 2024



Heat Wave in Delhi – May 2024



Flooding in Spain in 2024



Source: National Public Radio, USA



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

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/>

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

Customers Controlling Buildings Optimized for Savings

Energy savings from air conditioning control: 10-15%

Energy savings from lighting control: 15-20%



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



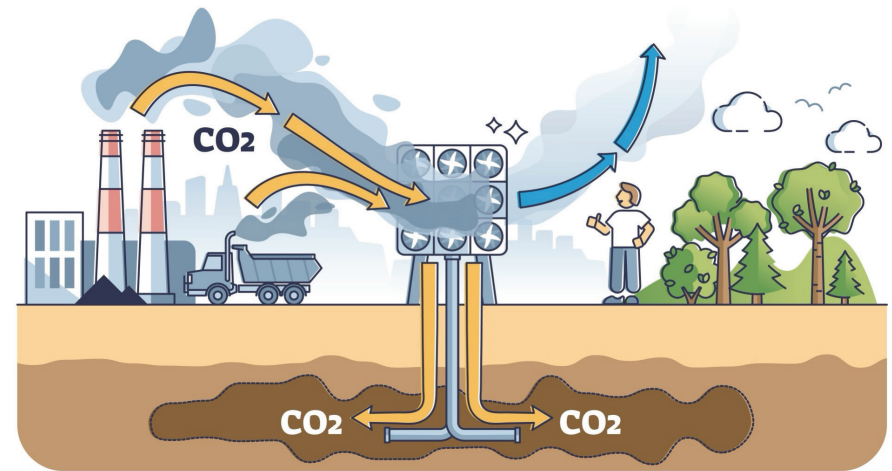
Highly Efficient Fossil-fuel Power Plants



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

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



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

Climate
Change

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Renewable Energy Integration

Whitelee Windfarm, Glasgow, Scotland



Kenya School of Monetary Studies, Nairobi



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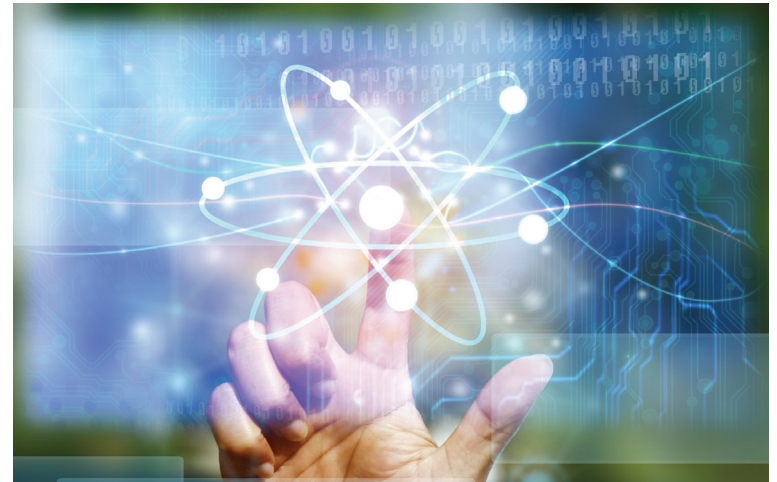
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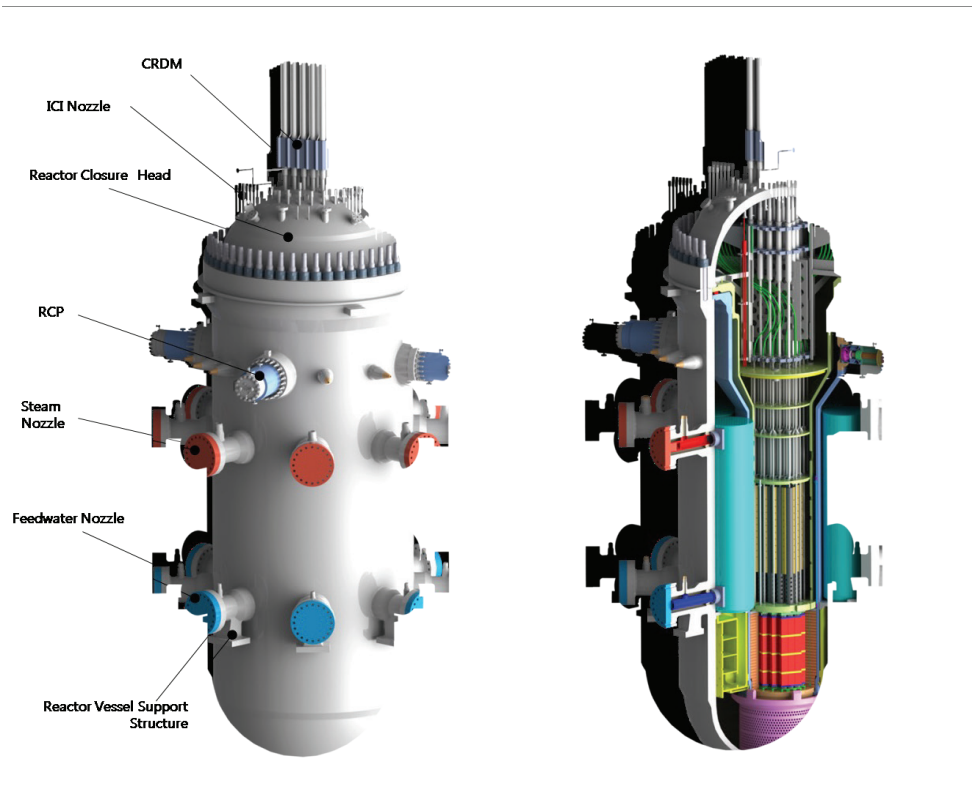
Advanced Nuclear Technologies

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

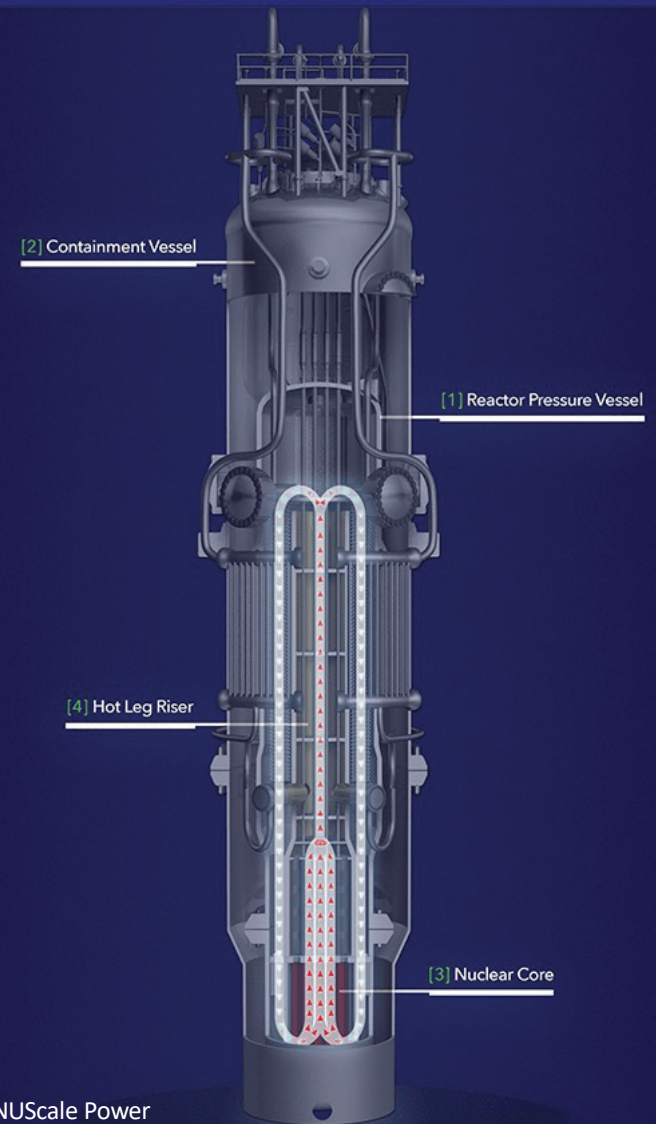


Small Modular Reactors (SMR)



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

© Saifur Rahman

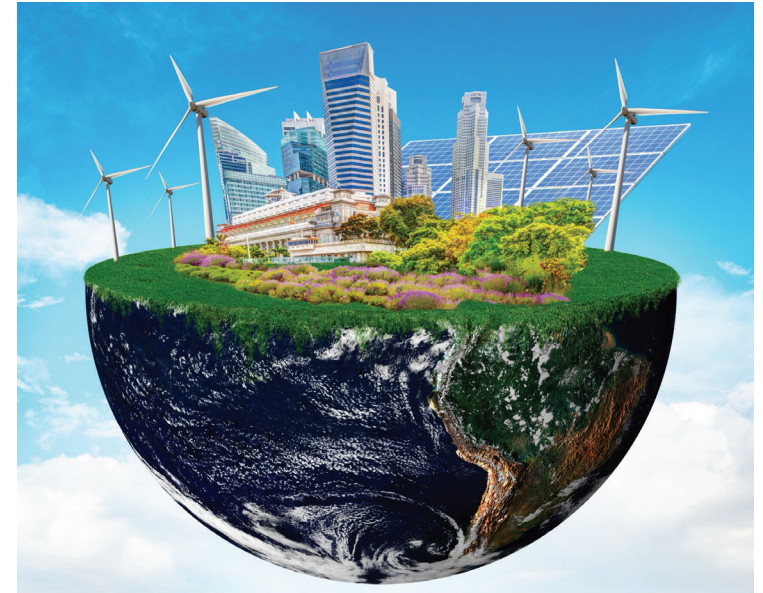


Source: NUScale Power

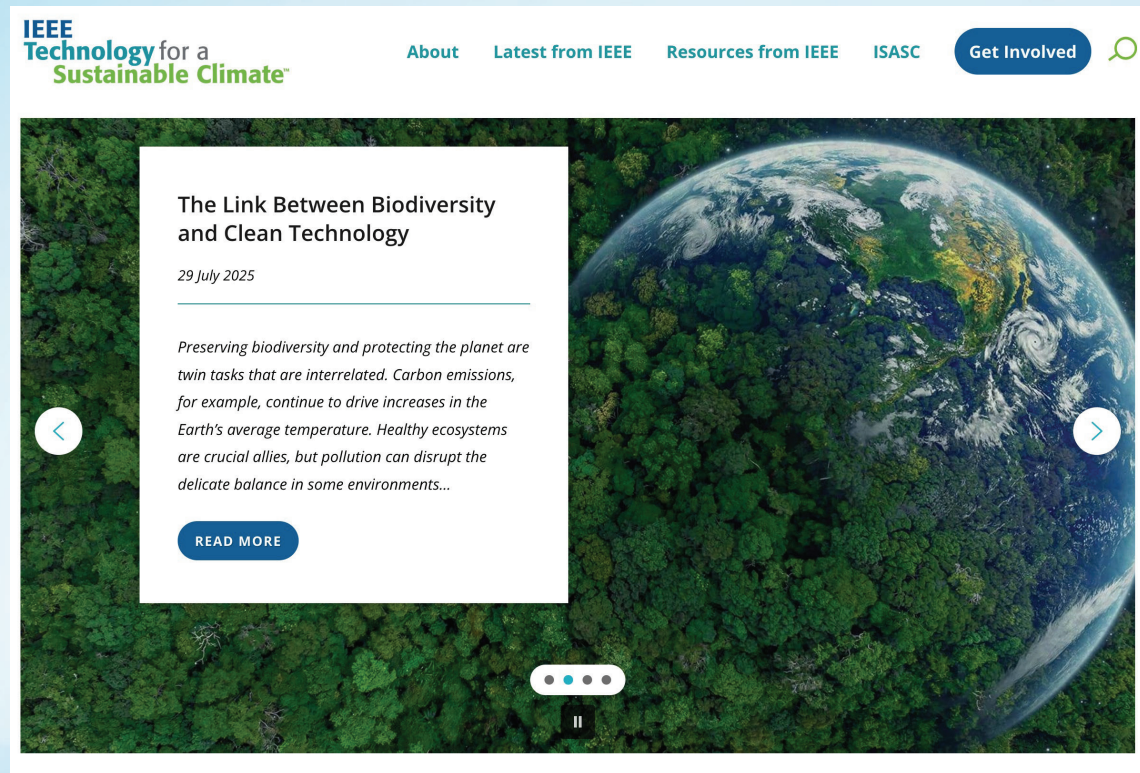
Cross-Border Energy Transfer

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



IEEE's Climate Change Program



sustainable.climate.ieee.org





IEEE at UN Conference on Climate Change Baku, Azerbaijan, November 2024, COP29



Green Digital Action Seminar at COP29



Youtube video: <https://lnkd.in/ehTFTW3w>

Energy Transition and Biodiversity





IEEE-ITU SYMPOSIUM *on* Achieving a Sustainable Climate

[ISASC HOME](#)[PROGRAM](#)[SPEAKERS](#)[PARTICIPATE](#)

PROGRAM

The second IEEE-ITU Symposium on Achieving a Sustainable Climate (ISASC) is being planned for 16-17 December 2025 with a new program that provides an update on progress of the collaborative Technology Roadmap.

[Click here](#) to stay abreast of developments.

isacr.ieee.org



IEEE-ITU Symposium to Achieve Climate Resilience

Geneva, 12-13 December 2024



The 2nd IEEE-ITU Symposium in Geneva, 16-17 December 2025



With the ITU Secretary General





United Nations
Climate Change

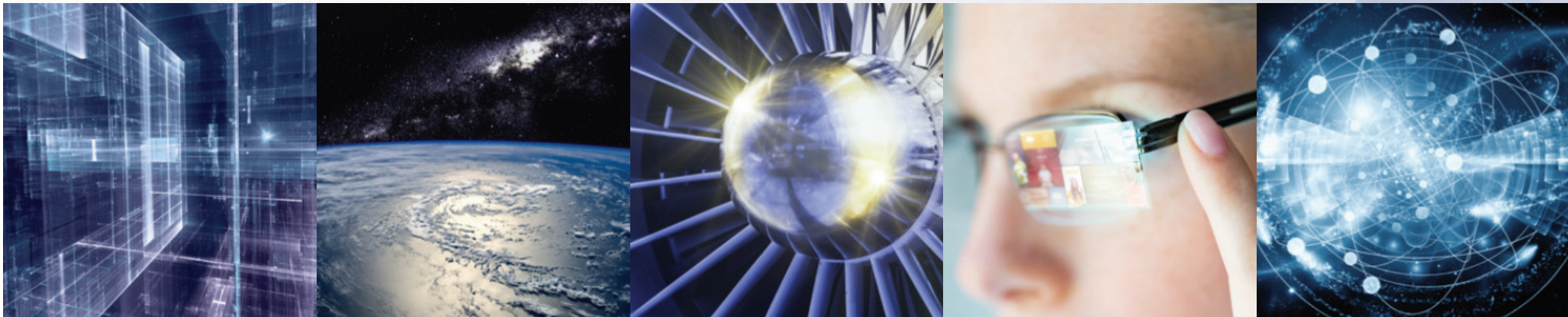


COP29
Baku
Azerbaijan

IEEE's Role in Driving Technology-Driven Climate Solutions at COP Events

The United Nations Conference of Parties (COP) is often seen as a platform for governments to negotiate emissions targets and financial pledges. Amid these ...





Thank You

Saifur Rahman, 2023 IEEE President

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