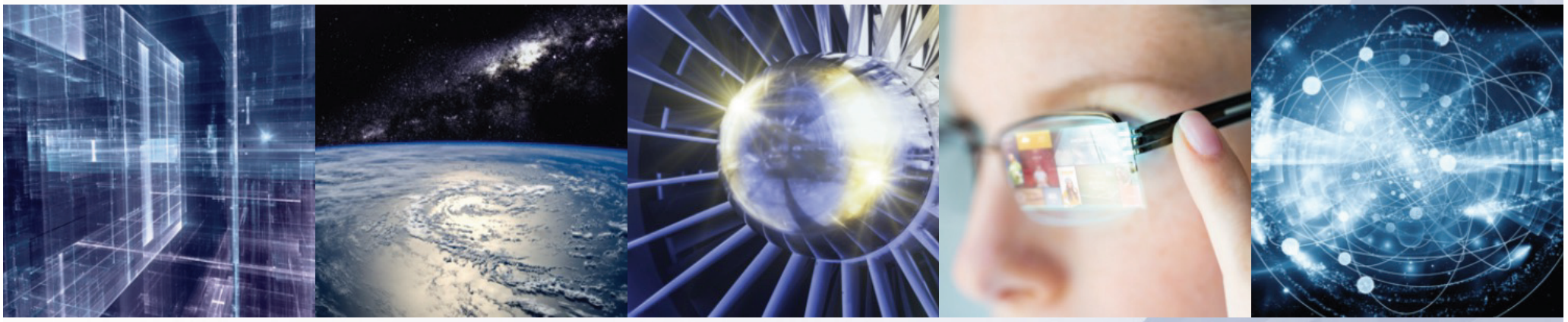

Technology Options to Address Climate Change Mitigation Needs

Keynote Speech

PECI Conference, Pubna Univ of Science & Technology, Bangladesh

Professor Saifur Rahman, IEEE Life Fellow
Director, Virginia Tech Advanced Research Inst.
2023 IEEE President
17-18 June 2026

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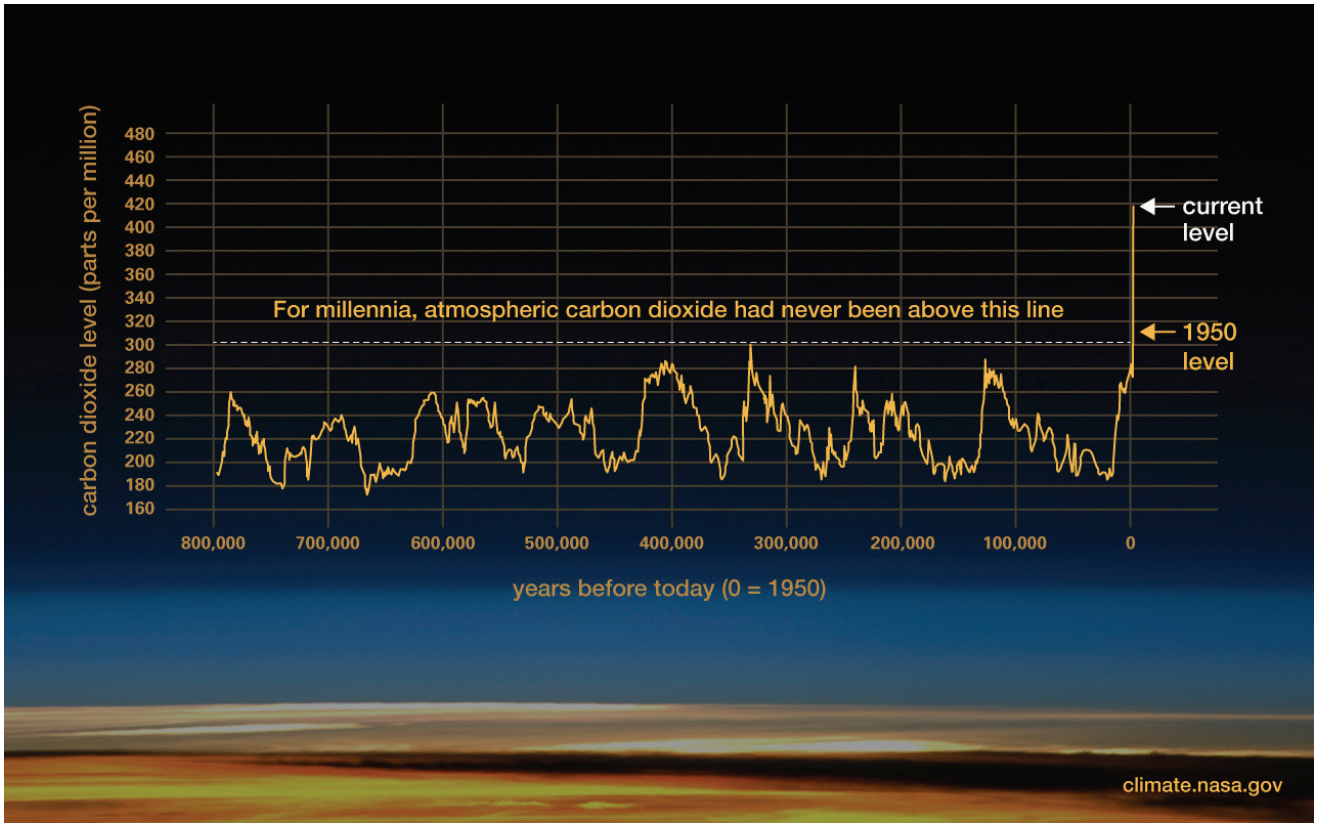
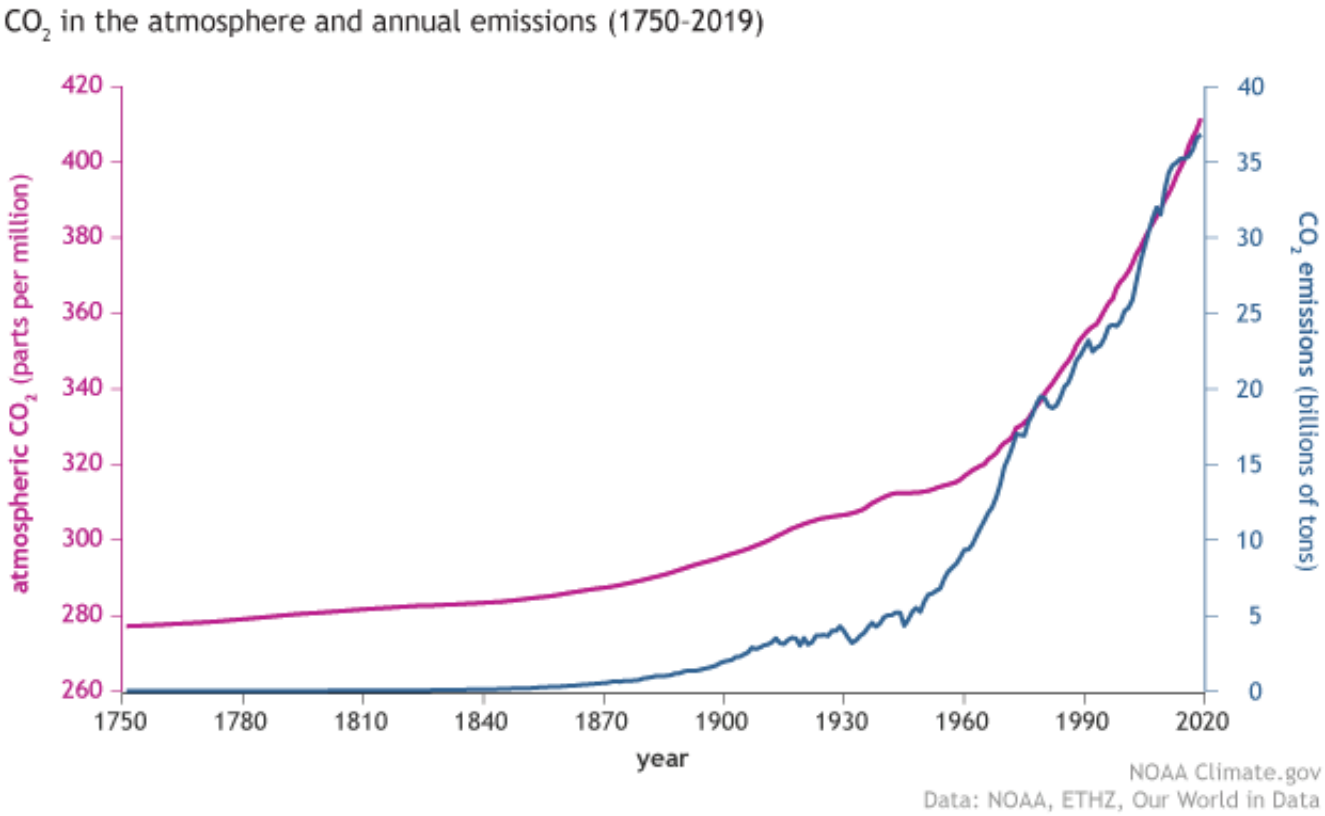
Date	Recent and Upcoming Presentations and Webinars	Webinar/Presentation Slides
17 June 2026 ***Bangladesh***	**Technology Options to Address Climate Change Mitigation Needs** Keynote Speech, Pubna University of Science & Technology, Bangladesh This lecture explains what carbonization is, addresses its 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	

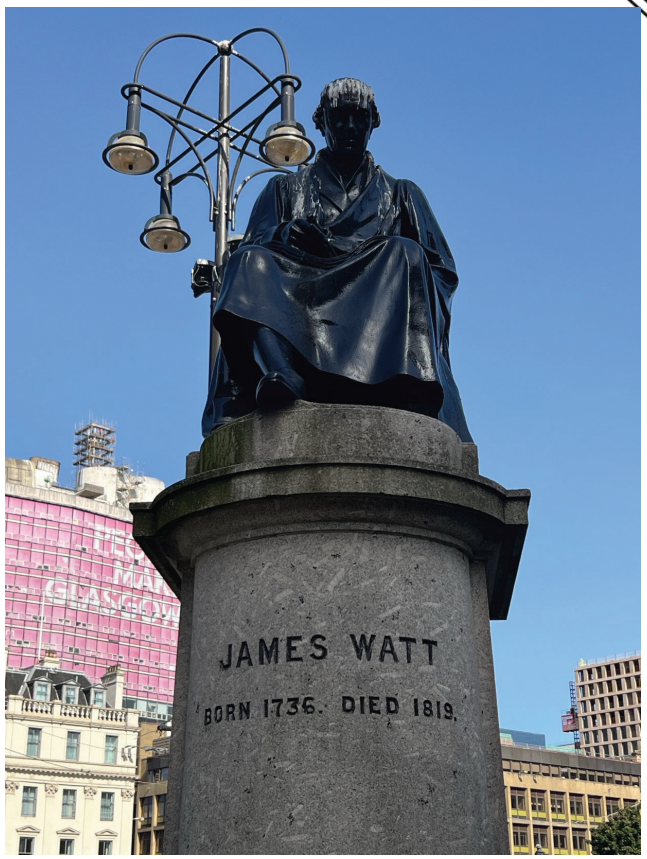
Carbonization is Challenging Climate Sustainability

What is Carbonization?



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





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

Impacts of Carbonization

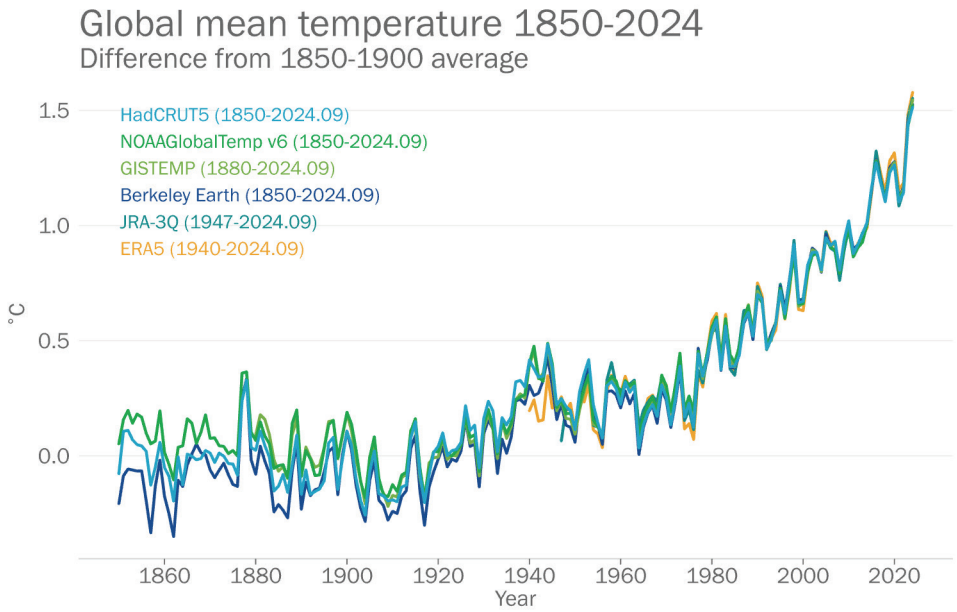
Global mean temperature
2024 was the warmest year on record

Global mean temperature
January-September 2024
1.54±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

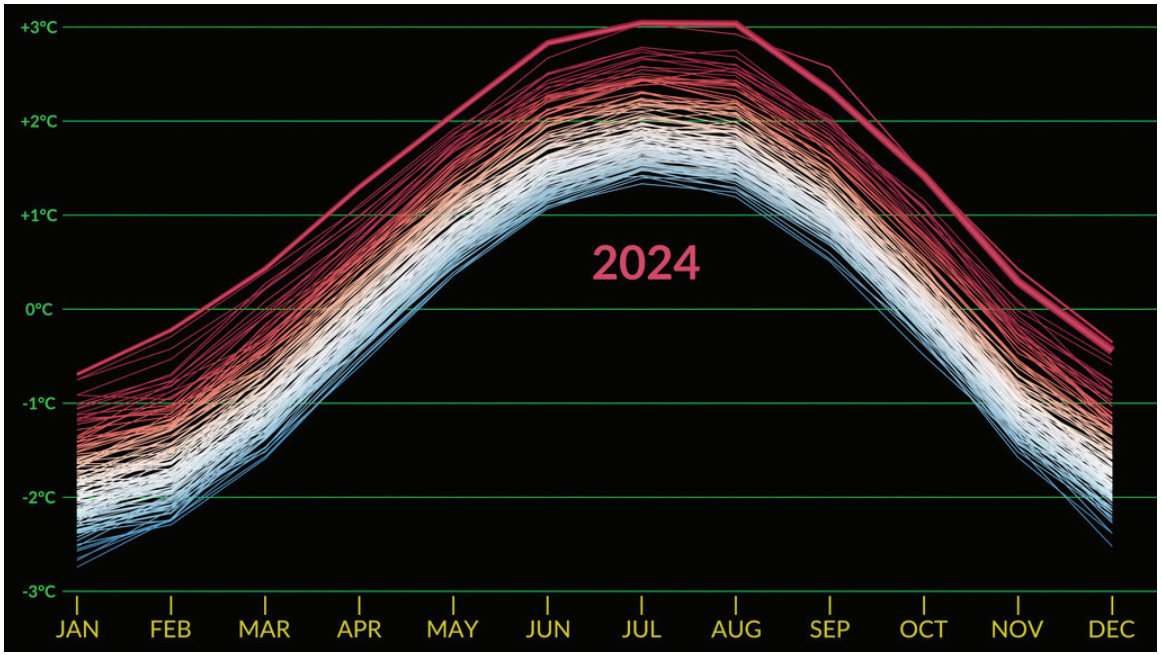
On track to be the warmest year in all six datasets

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



Source: World Meteorological Organization

https://svs.gsfc.nasa.gov/14743/



Global Temperature Graph 1880-Present:

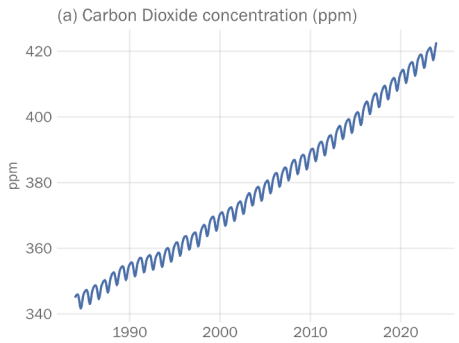
Earth's average surface temperature in 2024 was the warmest on record, according to an analysis led by NASA scientists. Global temperatures in 2024 were around 1.28 degrees Celsius above the agency's 20th century baseline (1951-1980). That is equal to a 2.30 degree Fahrenheit change and exceeds the record set in 2023. NASA scientists also estimate Earth in 2024 was about 1.47 degrees Celsius (2.65 degrees Fahrenheit) warmer than the mid-19th century average (1850-1900).

In 2024 the global average temperature was 1.47 deg C warmer than the average (1850-1900).

Paris Climate Conference target was a temperature increase of1.5 deg C by 2100

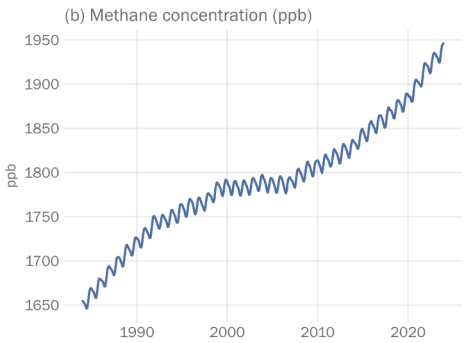
Greenhouse gas concentrations in the atmosphere reached record observed levels in 2023

Carbon Dioxide



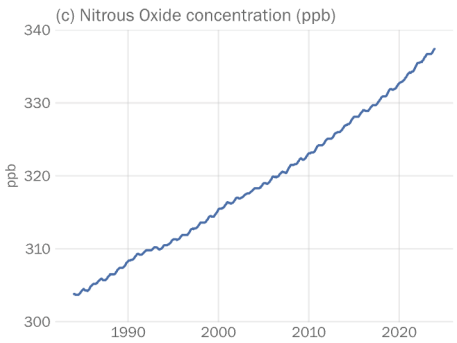
CO_2 in 2023
420.0±0.1 ppm
151% of 1750

Methane



CH_4 in 2023
1934±2 ppb
265% of 1750

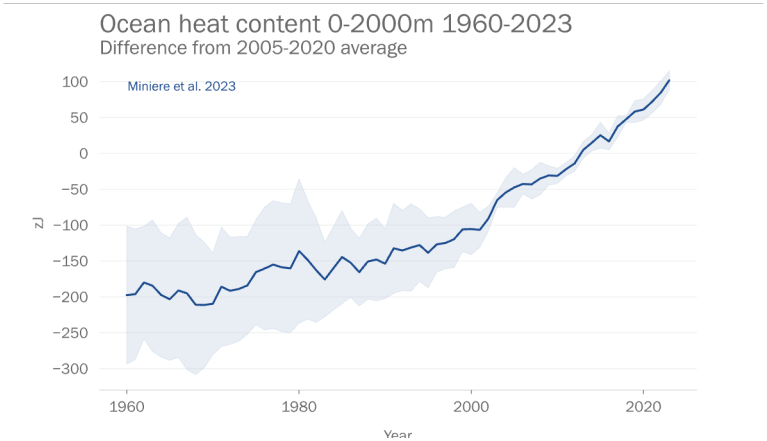
Nitrous Oxide



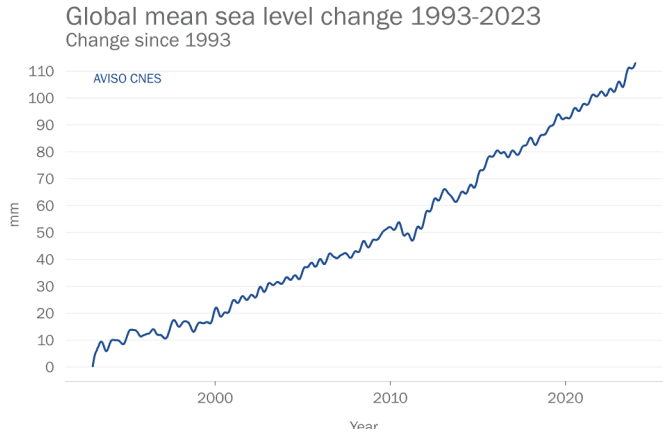
N_2O in 2023
336.9±0.1 ppb
125% of 1750

Data from World Data Centre for Greenhouse Gases

Ocean heat content 2023, highest on record
Sea level rise is accelerating



Ocean heat content in 2023 was the highest annual value on record, exceeding the 2022 value by 13±9 ZJ.



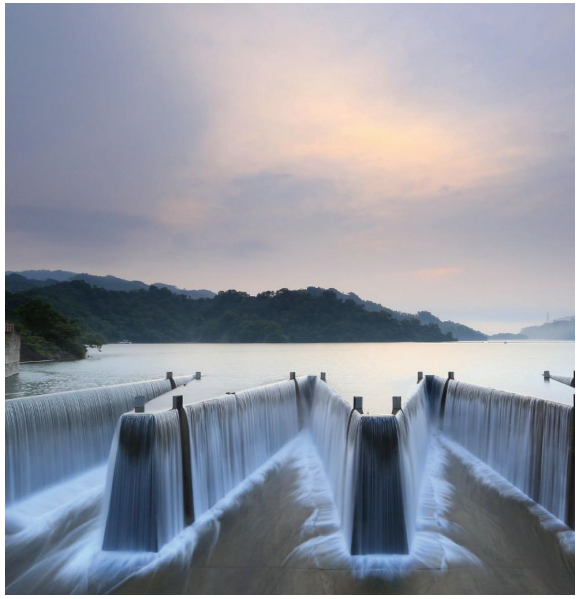
Sea level rise is accelerating. Rate increased from 2.13 mm·yr-1 between 1993 and 2002 to 4.77 mm·yr-1 between 2014 and 2023.

Source: World Meteorological Organization

ZJ ➡ Zeta Joule, 10e21

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

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/

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. -

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 H_2 & 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

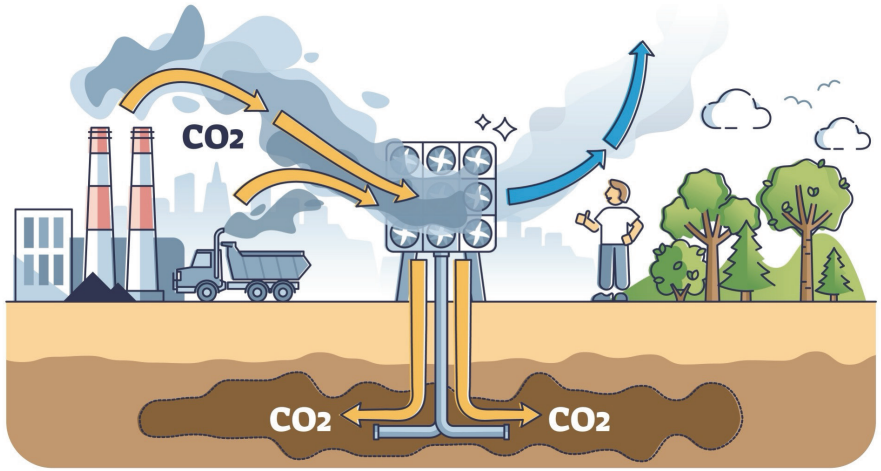
- The amount of electricity required to run an LED light bulb is less than 15% of what is needed to run an incandescent light bulb producing the same amount of light

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

Renewable Energy Integration

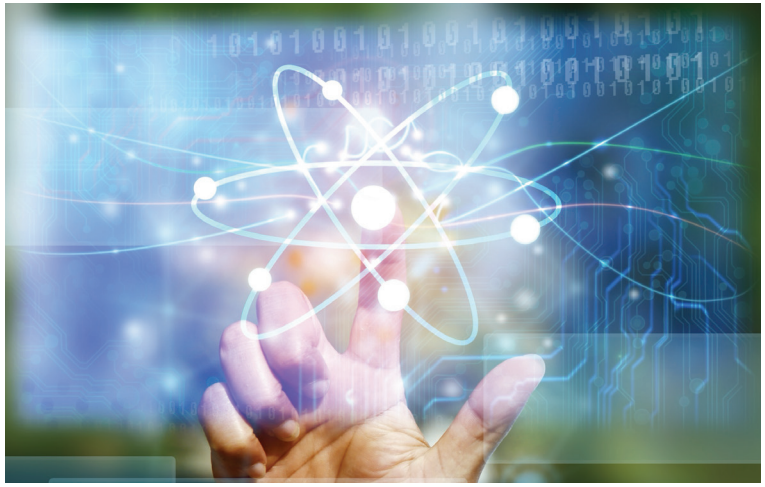
Whitelee Windfarm, Glasgow, Scotland

Kenya School of Monetary Studies, Nairobi

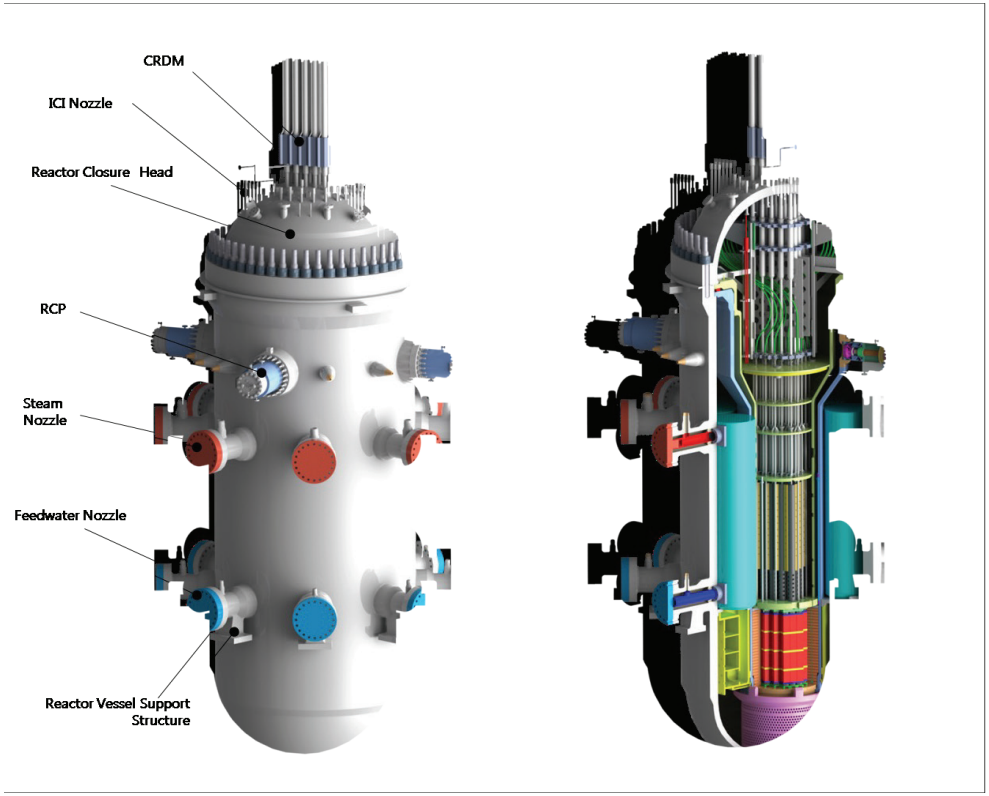
Advanced Nuclear Technologies

Diverse solutions to address climate change

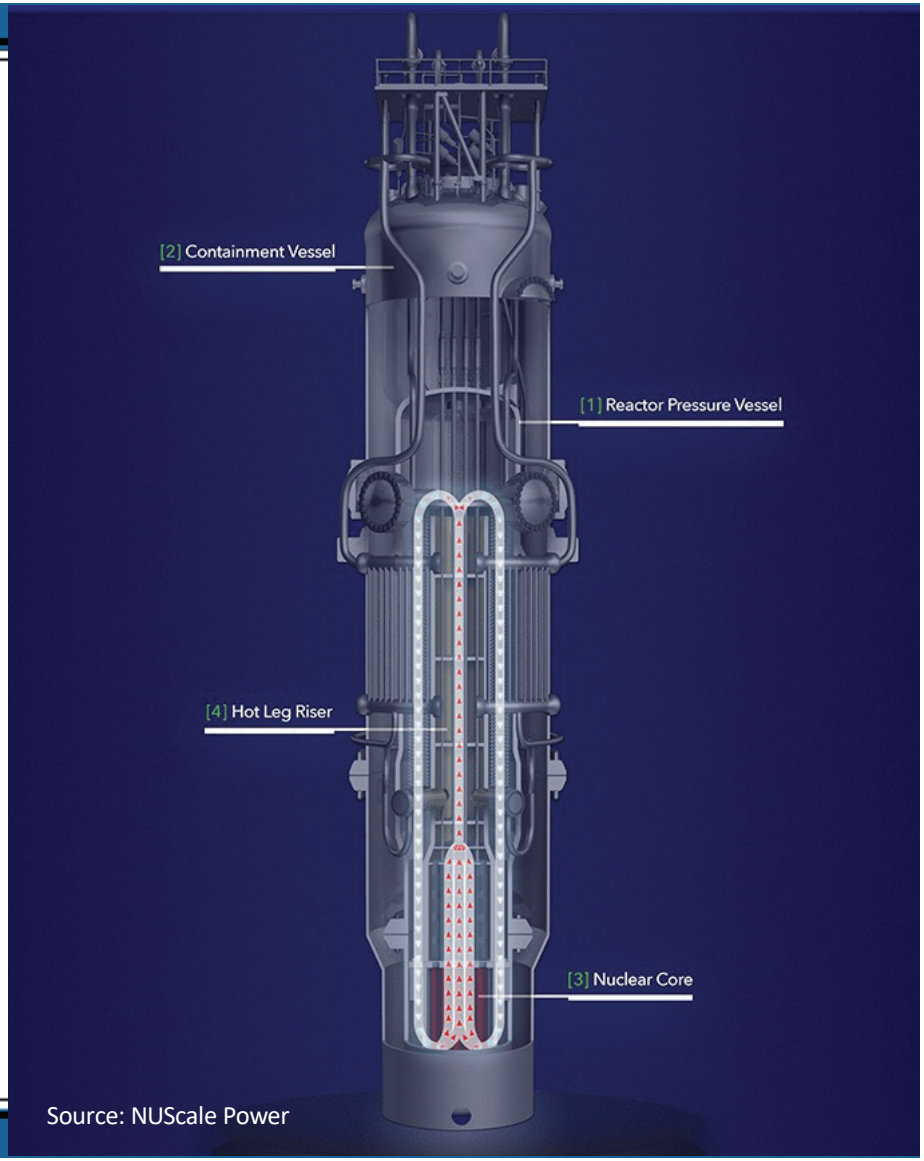
- Advanced nuclear technologies, such as small modular reactors (SMRs), can play a role
  - Smaller and can be built more quickly than more traditional nuclear reactors
- Ramping up the development of SMRs can help to produce energy when and where needed
- This energy could be integrated into existing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

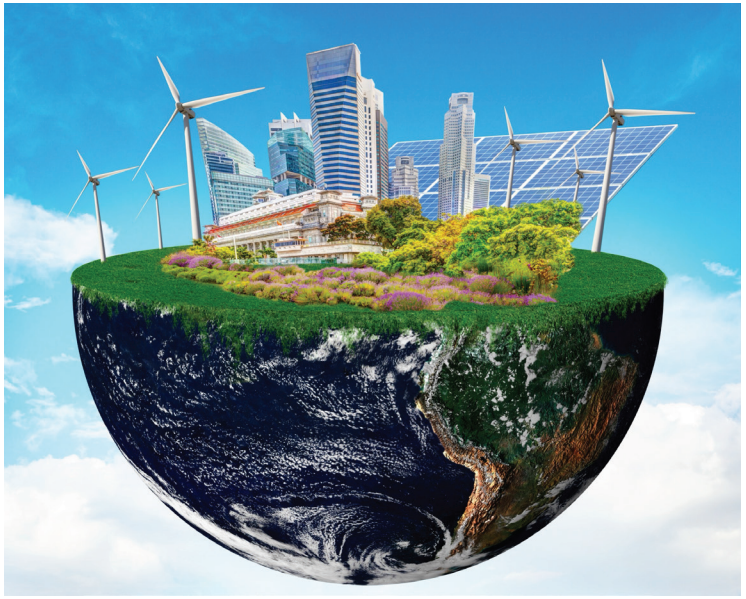


Source: NUScale Power

Cross-Border Energy Transfer

No Transition without Transmission

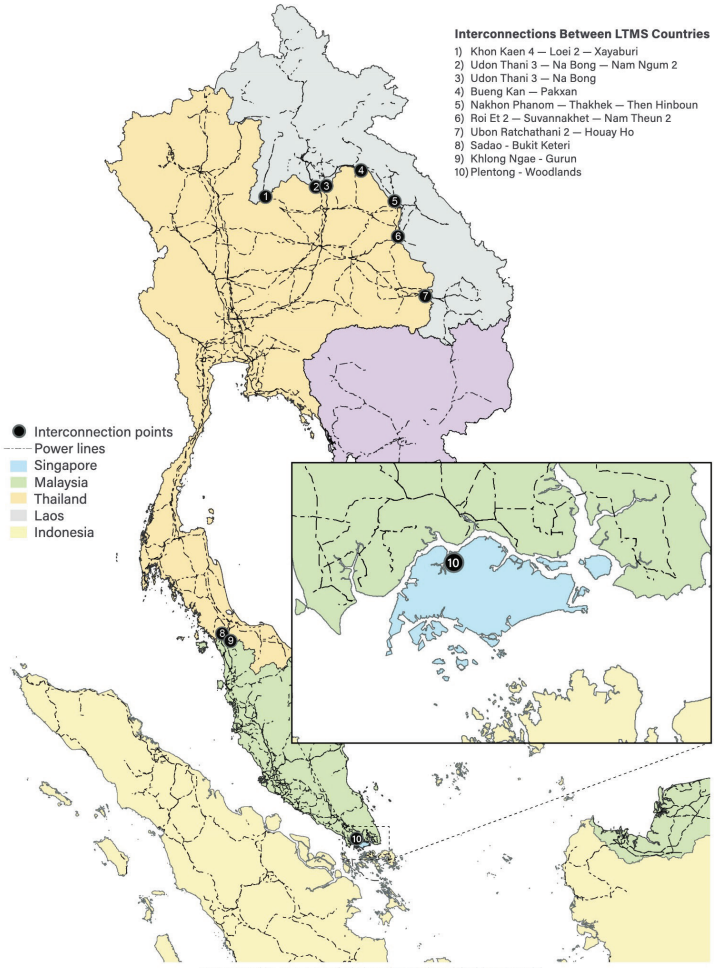
- As we are in this fight together, our solutions should be collaborative to secure better outcomes for all countries, regardless of location
- The International Energy Agency (IEA) has identified three main modes of cross-border energy integration:
  - Bilateral
  - Multilateral
  - Unified



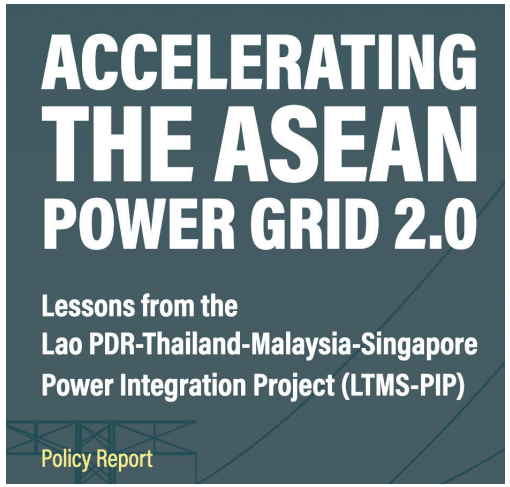
Some Case-specific Examples

Laos-Thailand-Malaysia-Singapore LTMS Interconnection

Figure 4. The Lao PDR-Thailand-Malaysia-Singapore Power Integration Project



Map created by ISEAS-Yusof Ishak Institute © (2023) (Subject to scale)

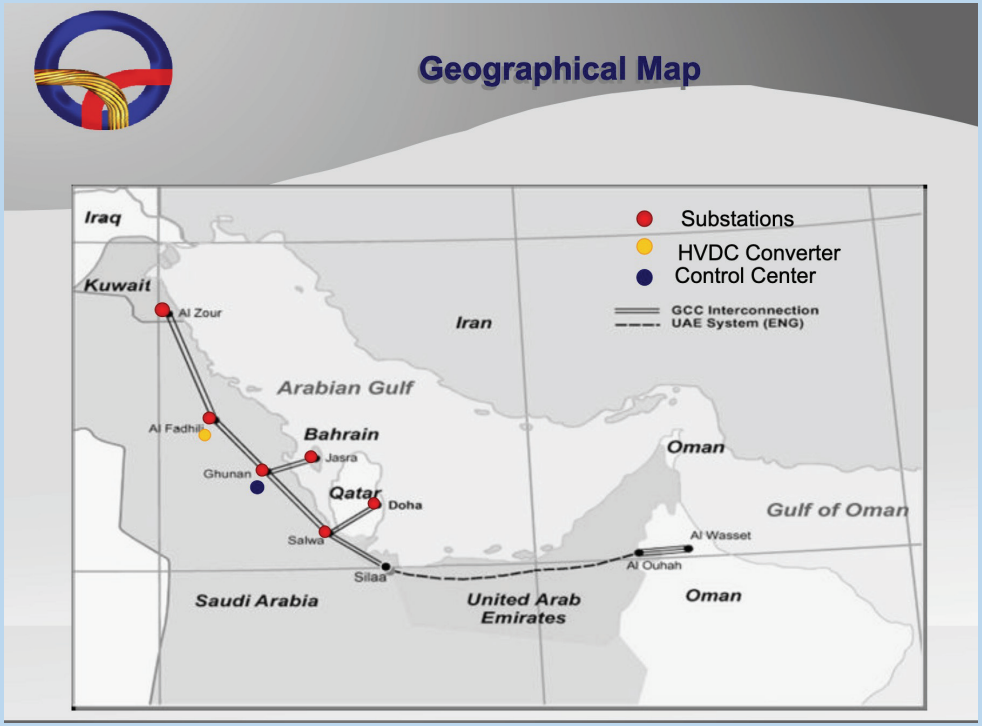


Vietnam has opted to boost hydroelectricity imports from Laos

The limited electricity transmission capacity from
the south to the north poses a major challenge.

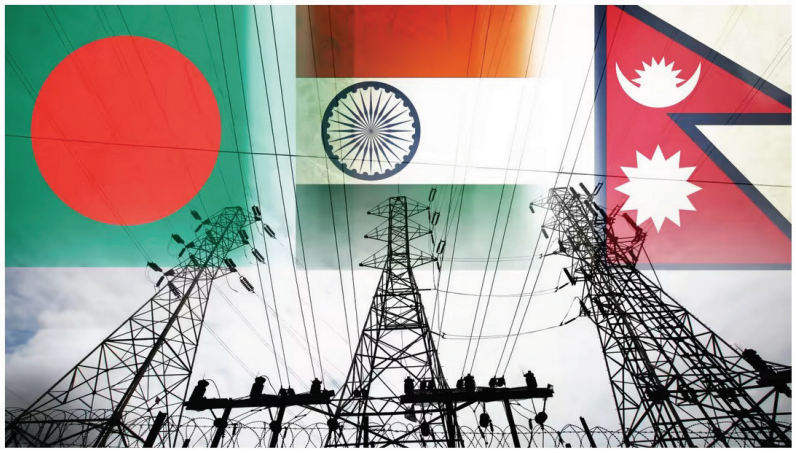
It is easier and more cost-effective to import hydro-electricity from Laos
to shore up power supply for the North,
given the shorter transmission distance.

Gulf Coordination Council Interconnection



Major Benefit: Reduction of Reserve Requirements
Also Helpful in Dealing with Intermittent Sources (PV)

Nepal needs to attract investment by developing a market outside



Bangladesh, India and Nepal are expected to soon finalize an agreement that would allow power sharing across Indian transmission lines. (Source photos by AP and Reuters)

In Nepal electricity demand is less in summer than in winter
It is <u>opposite</u> in India and Bangladesh due to high air conditioning load

Advancing Technology for Humanity

What Can you Do to Serve Humanity?

Clean-Tech Solutions for Climate Sustainability

Climate Change

IEEE: Enabling Innovation and Technology Solutions

IEEE

IEEE's Climate Change Program

Climate Change

IEEE: Enabling Innovation and Technology Solutions

https://sustainable-climate.ieee.org

IEEE at UN Conference on Climate Change

Belem, Brazil, November 2025, COP30

https://cop30.br

Strengthening Capacity Building for Energy Transition, COP30, Brazil

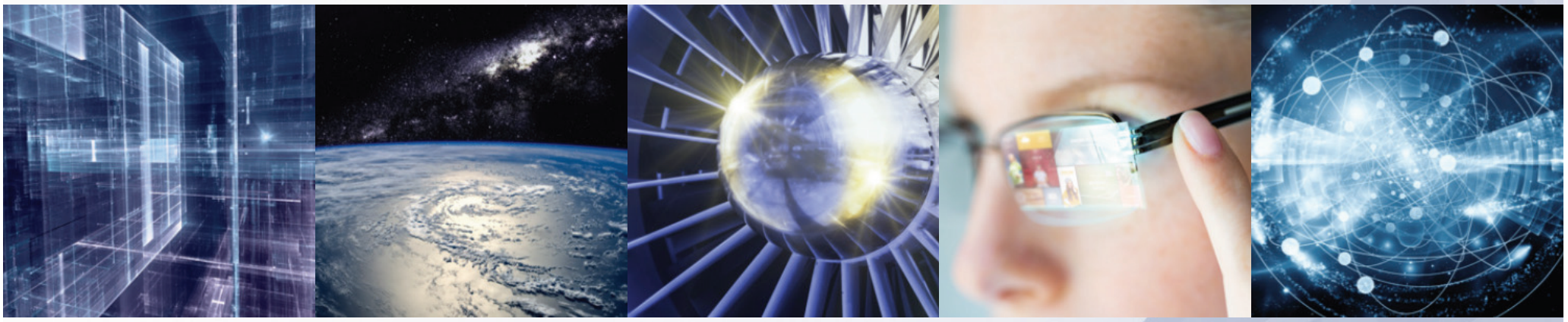
IEEE-ITU Symposium on Achieving a Resilience Climate

Geneva, 15-16 December 2025

https://isasc.ieee.org

IEEE-ITU Symposium Opening Speech

https://isasc.ieee.org



Thank You

Saifur Rahman, 2023 IEEE President

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