Promoting Clean-tech Solutions for Climate Sustainability Challenges and Opportunities

Invited Talk
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What is Carbonization?
For millennia, atmospheric carbon dioxide had never been above this line.

Source: NASA
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
Advancing Technology for Humanity

Temperature rise since 1850

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

Source: Met Office


Temperature rise target is below 1.5. More than 2.0°C Point of No Return
The July global surface temperature was 1.12°C (2.02°F) above the 20th-century average of 15.8°C (60.4°F), making it the warmest July on record. This marked the first time a July temperature exceeded 1.0°C (1.8°F) above the long-term average.

July 2023 was 0.20°C (0.36°F) warmer than the previous July record from 2021. July 2023 marked the 47th-consecutive July and the 533rd-consecutive month with temperatures at least nominally above the 20th-century average.
Monthly temperature anomalies from 1880 to August 2023 measured with respect to the baseline period 1951-1980.

This graph includes the seasonal cycle showing that June 2023, July 2023, and August 2023 were each consecutively the warmest month on record.
Climate-change Impacts
Flooded street after heavy rains in Zhuozhou, in northern China's Hebei province August 2, 2023. (AFP)


Residents are evacuated by rubber boats through flood waters in Zhuozhou in northern China’s Hebei province, south of Beijing, Wednesday, Aug. 2, 2023. China’s capital has recorded its heaviest rainfall in at least 140 years over the past few days. Among the hardest hit areas is Zhuozhou, a small city that borders Beijing’s southwest. (Andy Wong/AP)

Source: https://www.stripes.com/theaters/asia_pacific/2023-08-02/beijing-china-rainfall-deaths-10925575.html/
Flooding in Pakistan – August 2022

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

Brazil

Aerial view of the area affected by an extratropical cyclone in Rio Grande do Sul State, Brazil Sept 2023
(AGENCIA RBS/AFP via Getty Images)
Flooding in Libya

Thousands of Lives Lost
Greece

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

Cars in a flooded road in the city of Volos, central Greece
(AFП via Getty Images) Sept 2023
Droughts in 2022

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.
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. 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

Advancing Technology for Humanity
Algeria/Tunisia

- Death toll at least 34 fatalities, including 10 firefighters in Algeria
- At least 26 others have been injured.
- Over 1,500 people evacuated in Bejaia, Bouira, and Jijel, Algeria
- Over 2500 evacuated from Maloula and Tabarka in Tunisia

Source: Crisi24
https://crisis24.garda.com/

Burnt vehicles are pictured in the aftermath of a wildfire in Bejaia, Algeria July 25. REUTERS/Ramzi Boudina


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Siberia: Wildfires in June 2020 and June 2021
Before/After image of Fire Damage in Kiotari Rhodes, Greece
Source: Maxar Technologies via BBC. July 2023
Opportunities of Decarbonization in the Electric Power Supply Industry

Source: IEEE Spectrum, Jan 2023

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).
Eemshaven ultra-supercritical steam power plant, The Netherlands

- **Power Plant:** Two units rated 800MW each
- **Efficiency:** 46.2%
- **Temp:** 609 deg C
- **Steam Turbine:** Siemens SST5-6000
- **Built:** 2014

*Advancing Technology for Humanity*
Carbon Capture & Storage Systems (CCS)

- 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
ScotWind leasing round on the 17th of January 2022: **25 GW**

Demand for Electricity in Scotland in 2030: **6 GW**
LONDON, Aug 24 (Reuters) - British authorities have given planning consent for a new 2 gigawatt (GW) subsea power link between Scotland and England.

The Eastern Green Link 2 will be developed by National Grid and Scottish and Southern Electricity Networks Transmission.
Gulf Coordination Council Interconnection

Major Benefit: Reduction of Reserve Requirements
Also Helpful in Dealing with Intermittent Sources (PV)
Bangladesh-India Interconnection (HVDC link)

Bangladesh-India 400 KV Double-Circuit 1,000 MW Line

Allows Bangladesh to buy cheaper electricity and solar electricity when available
Nepal needs to attract investment by developing a market outside
In Nepal electricity demand is less in summer than in winter
It is opposite in India and Bangladesh due to high air conditioning load
Industry tends to locate in areas of low-carbon electricity to help meet their own net-zero targets for scope II and scope III emissions.

Low-carbon, cheaper and non-intermittent electricity

545 km of underwater-underground transmission line from Québec, Canada to New York City.
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 to import hydro-electricity from Laos to shore up power supply for the North, given the shorter transmission distance.
Clean-tech Solutions for Climate Sustainability
https://climate-change.ieee.org
IEEE Climate Change Program

https://climate-change.ieee.org

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BUILDING Technical Community
CLIMATE CHANGE Mitigation

email: ccircc@ieee.org
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