University of Macao Public Lecture
12 May 2023

Technologists’ Role in Addressing Climate Sustainability

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IEEE President & CEO 2023

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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/
# Global CO₂ Emissions Due to Fossil Fuel Use in 2021

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Emissions (billion tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>15.3</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>7.5</td>
</tr>
<tr>
<td>Oil</td>
<td>10.7</td>
</tr>
</tbody>
</table>

Source: IEA Global Energy Review: CO₂ Emissions in 2021
CO₂ emissions in selected emerging and advanced economies, 2000-2021


Fluorinated Gases include: HFC, PFC and SF6

Source: https://ourworldindata.org/greenhouse-gas-emissions#annual-greenhouse-gas-emissions-how-much-do-we-emit-each-year
Source: https://www.c2es.org/content/international-emissions/
Impacts of Carbonization
**Temperature rise since 1850**

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

![Temperature Graph](https://www.bbc.com/news/science-environment-51111176)

Source: Met Office


**Temperature rise of 1.5 – 2.0 °C = Point of No Return**
Africa, China and Florida, USA
Flooding in Pakistan 2022
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/5r2AzhxEvxM
Hurricane Sandy
New York, New Jersey 2012
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 18 August 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. 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. All Photos: Michael Sreeg, ILA

Climate Change

DRD: Enabling Innovation and Technology Solutions
2008 China Snowstorm
Electrification to Reduce Fossil Fuel Use
Electric vehicle

Heat pump as opposed to oil/gas furnace
Heavy electrification will **double** electricity demand in 10-15 years

We need to rethink how we use, and produce electricity
Major focus placed on the carbon produced through electricity generation, as it is responsible for roughly 30% of emissions globally.
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

Source: NUScale Power
IEEE can be a solution partner

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

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IEEE’s Climate Change Program

IEEE: Enabling Innovation and Technology Solutions
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
IEEE at UN Climate Change Conference
Partnership with International Renewable Energy Agency (IRENA)

Founding Partners: Energy Transition Education Network
COP27 Event by IRENA

Energy Transition Education Network
Ongoing Climate Change Related Activities Across IEEE
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.

Climate Change Pavilion at SC2023
THANK YOU!

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