Climate Change and Net-zero Transition
A Roadmap for Industrializing Countries

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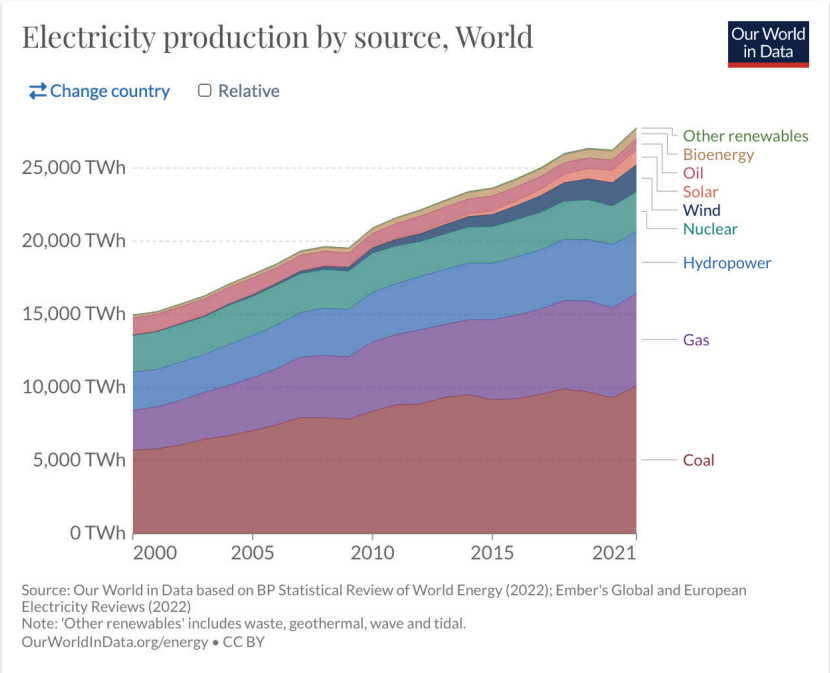
2023 IEEE President & CEO

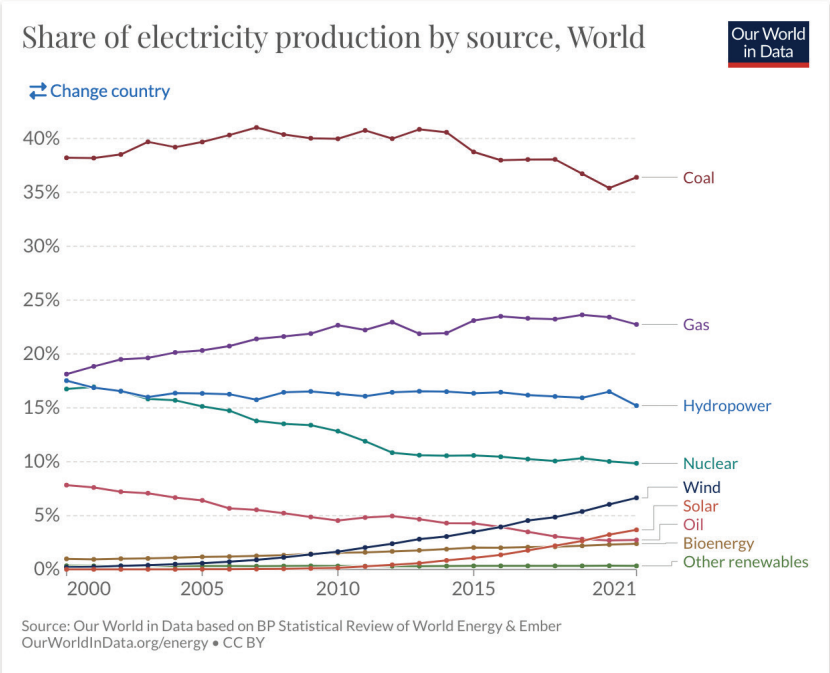
www.srahman.org

Keynote Speech

IEEE Bangladesh Section Technical Expert Forum,
Institution of Engineers, Dhaka, 24 June 2023

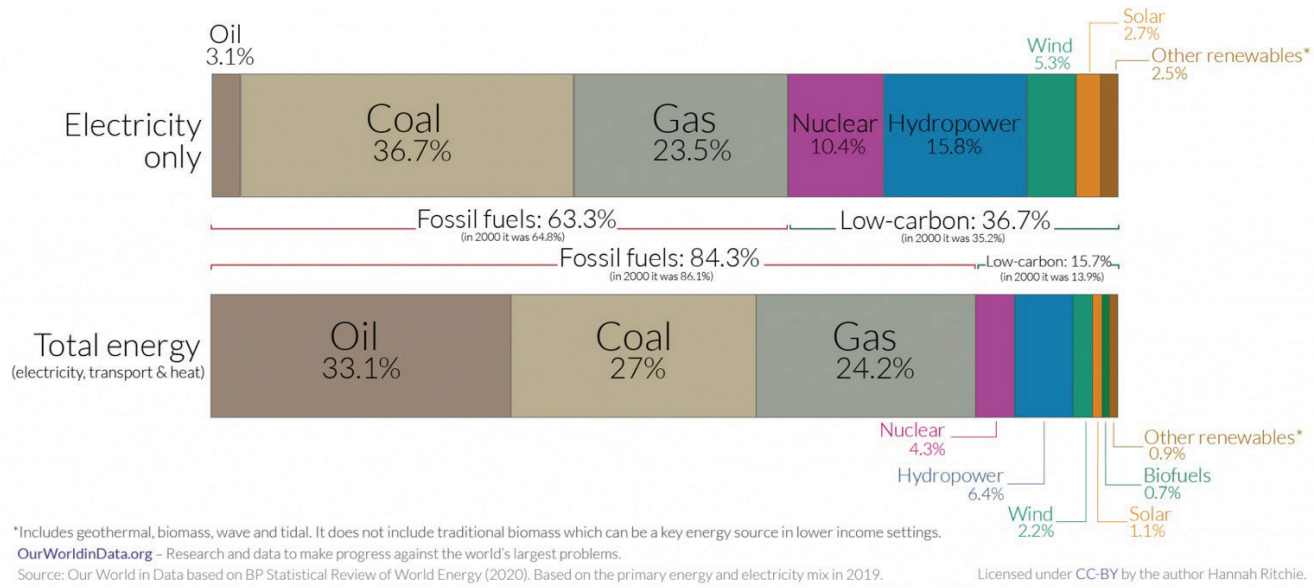
Evolution of Global Electricity Generation Mix





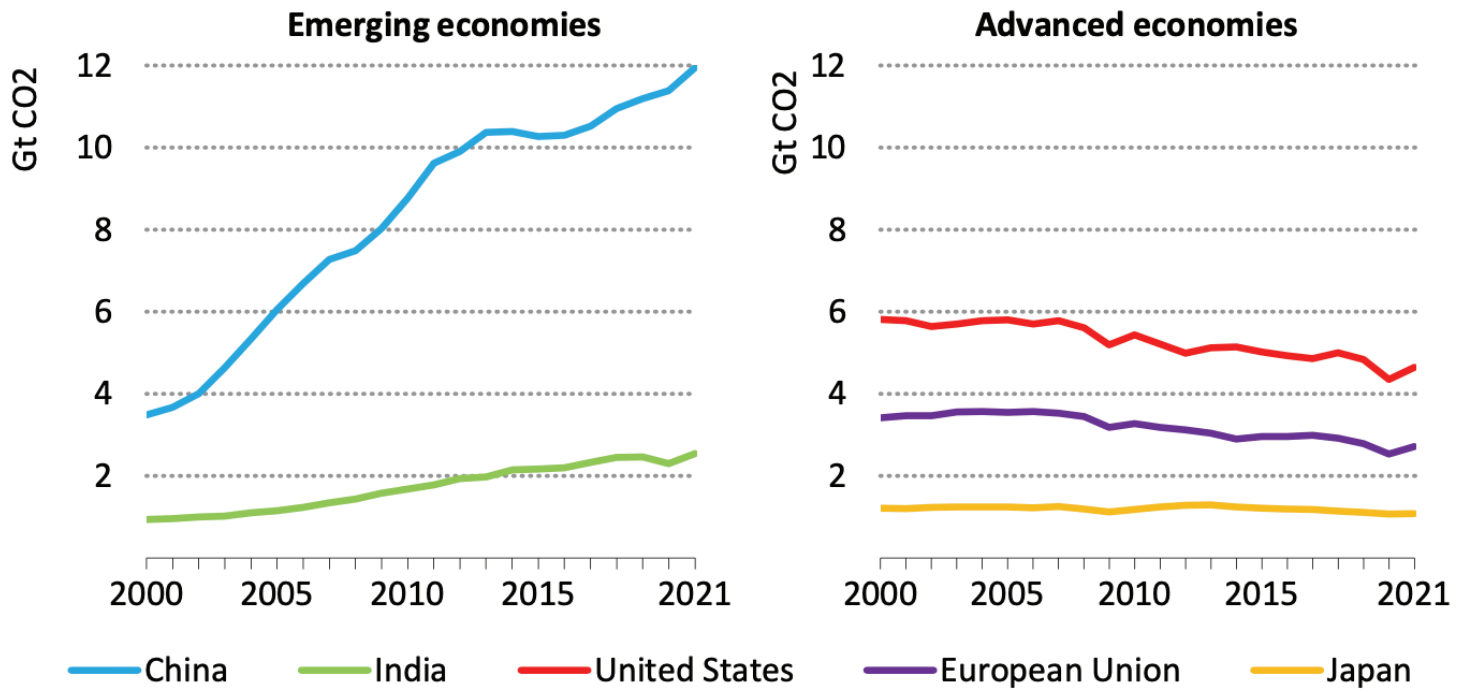
Year	Total Generation (TWH)
2000	14,968
2021	27,783

Global Energy Use in 2019



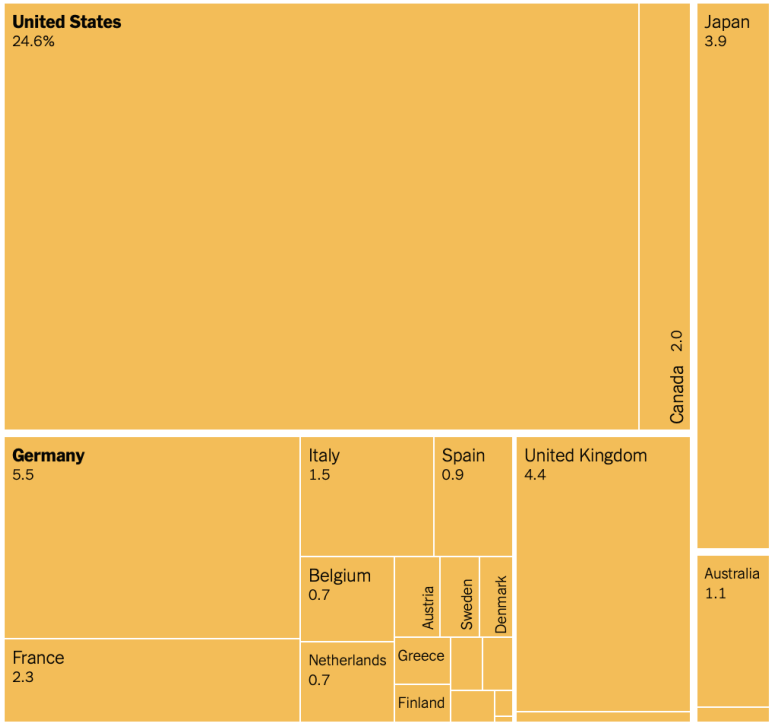
Source: https://ourworldindata.org/electricity-mix

CO_2 Emissions in Selected Emerging and Advanced Economies, 2000-2021

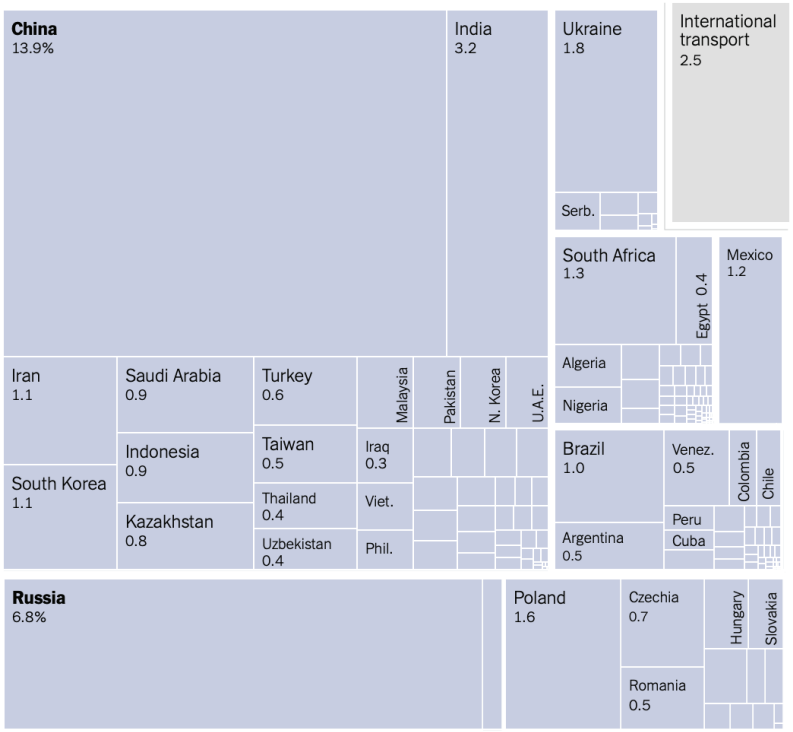


Who Has the Most Historical Responsibility for Climate Change

23 rich, developed countries are responsible for half of all historical CO_2 emissions.

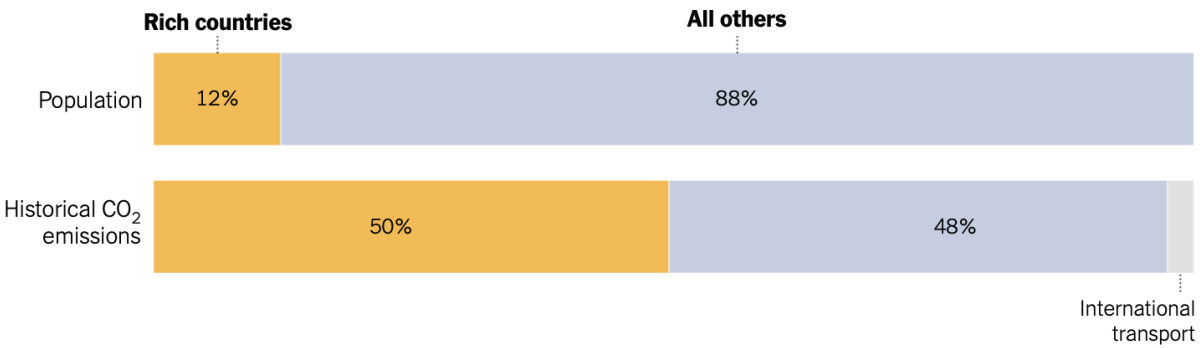


More than 150 countries are responsible for the other half.

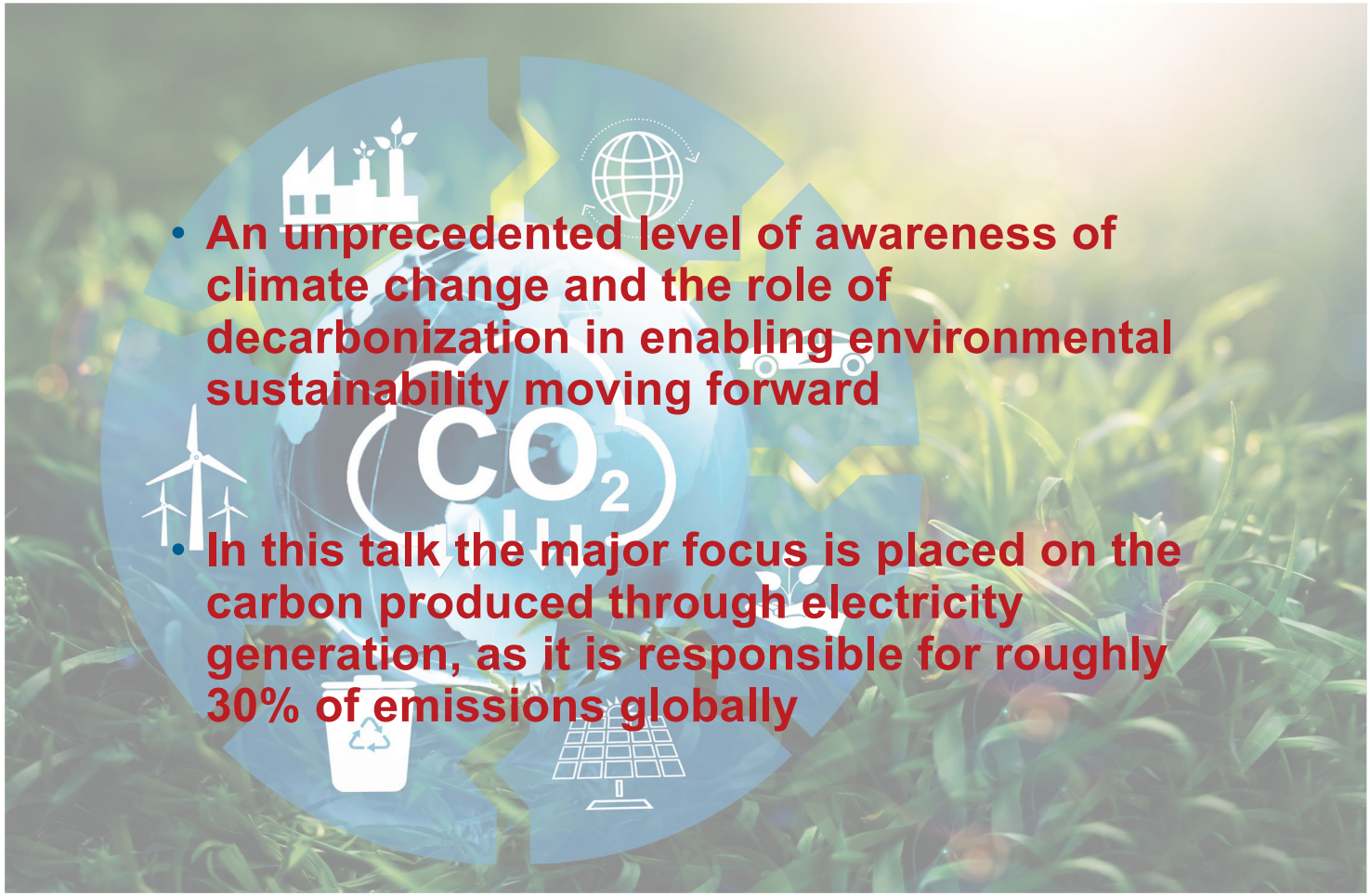


Who Has the Most Historical Responsibility for Climate Change

Rich countries, including the United States, Canada, Japan and much of western Europe, account for just 12 percent of the global population today but are responsible for 50 percent of all the planet-warming greenhouse gases released from fossil fuels and industry over the past 170 years.



Source: The New York Times article "Who Has The Most Historical Responsibility for Climate Change?" by By Nadja Popovich and Brad Plumer, Nov. 12, 2021 (https://www.nytimes.com/interactive/2021/11/12/climate/cop26-emissions-compensation.html)



- An unprecedented level of awareness of climate change and the role of decarbonization in enabling environmental sustainability moving forward
- In this talk the major focus is placed on the carbon produced through electricity generation, as it is responsible for roughly 30% of emissions globally

Navigating the tension between industrialized nations and emerging economies for global decarbonization efforts requires a diverse portfolio of solutions for low-carbon generation, storage and demand side management with advanced technology focusing on energy efficiency.

To more efficiently facilitate the global shift towards renewable energy adoption, the following six areas should be our priority.

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

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 (CO_2 levels, PM 2.5).

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
- Providing developing nations with lightbulbs that are more energy efficient can ensure that energy consumption and carbon emissions are being reduced requiring lesser investments in power generation, transmission & distribution

Highly Efficient Fossil-fuel Power Plants

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

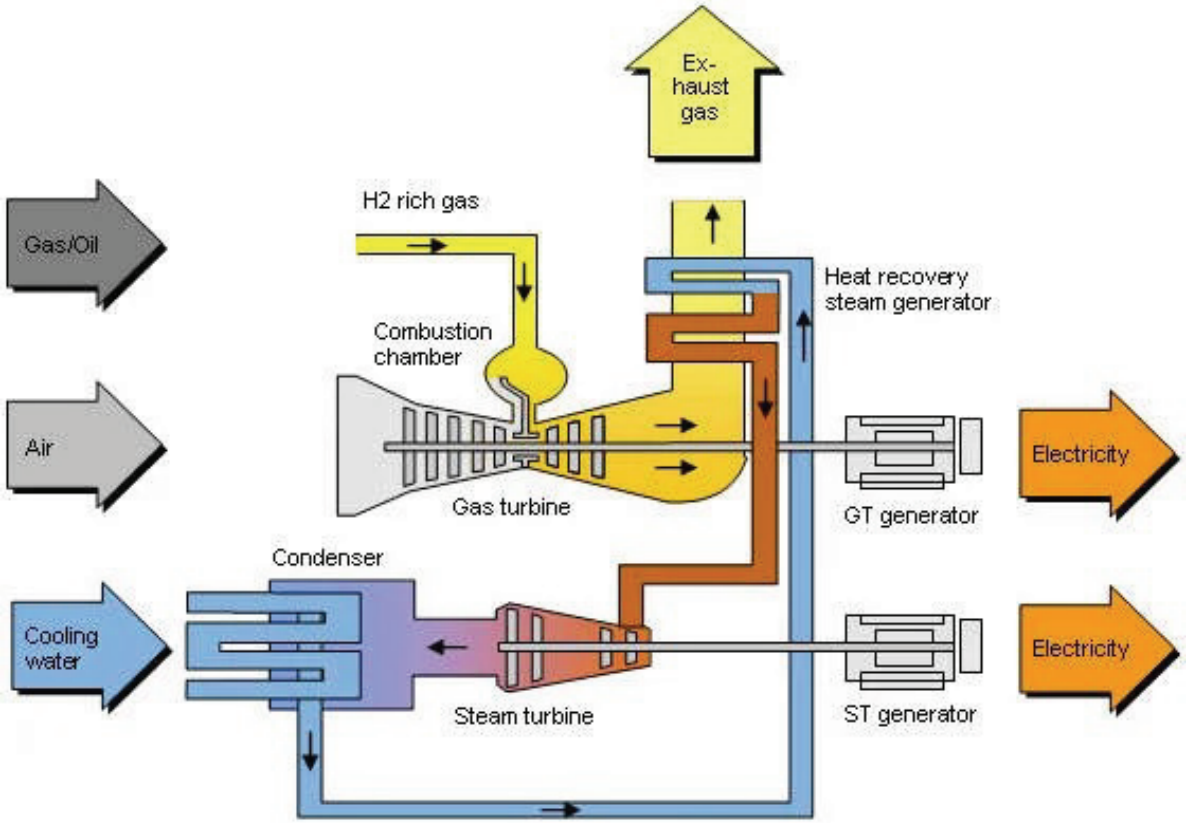


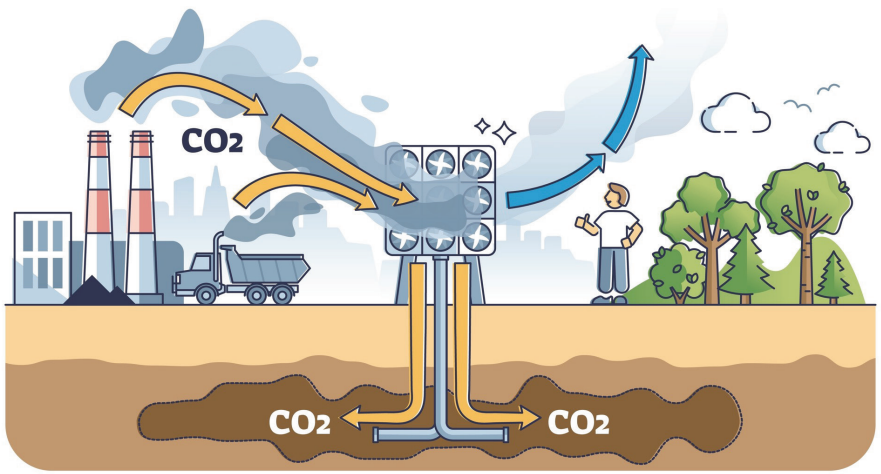
Image courtesy of: http://www.powergeneration.siemens.com

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

Carbon Capture & Storage Systems (CCS)

- Can help ensure that emissions created during the energy generation phase will not be emitted into the atmosphere
- Direct Air Capture



Hydrogen and Storage Solutions

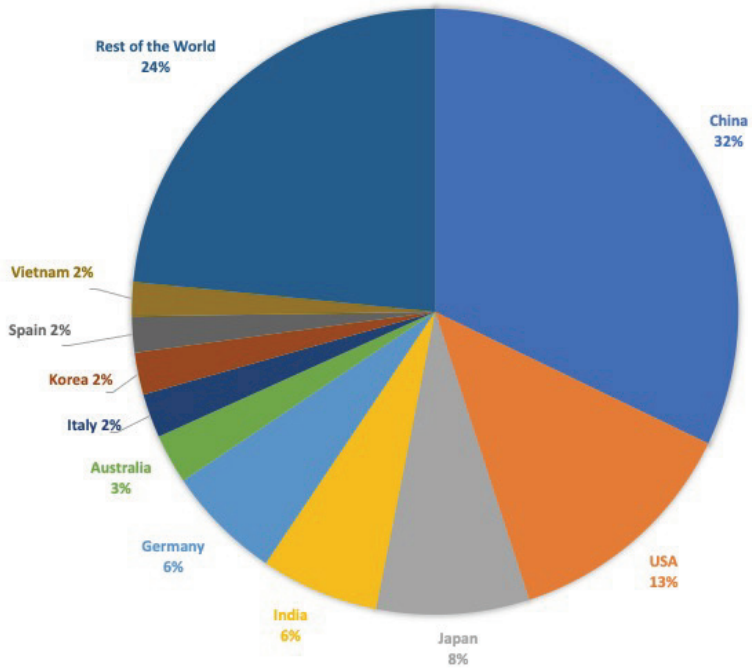
Optimize renewable energy solutions being integrated into energy grids

- 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 renewable/nuclear energy solutions
- Ensure that electricity generated during off-peak hours does not go to waste

Changing Landscape for the Electric Utility

Roof-top Solar Photovoltaics in Virginia

Global Cumulative Installed PV Capacity Showing Top 10 Countries
End of 2021 (942GW)



Source of Data: IEA, Snapshot of Global PV Markets: 2022

PV Annual and Cumulative Installed Capacity

Top 10 countries (2021)

TABLE 1: TOP 10 COUNTRIES FOR INSTALLATIONS AND TOTAL INSTALLED CAPACITY IN 2021

FOR ANNUAL INSTALLED CAPACITY			FOR CUMULATIVE CAPACITY		
1	China	54,9 GW	1	China	308,5 GW
2	USA	26,9 GW	(2)	European Union*	178,7 GW
(3)	European Union*	26,8 GW	2	USA	123 GW
3	India	13 GW	3	Japan	78,2 GW
4	Japan	6,5 GW	4	India	60,4 GW
5	Brazil	5,5 GW	5	Germany	59,2 GW
6	Germany	5,3 GW	6	Australia	25,4 GW
7	Spain	4,9 GW	7	Italy	22,6 GW
8	Australia	4,6 GW	8	Korea	21,5 GW
9	Korea	4,2 GW	9	Spain	18,5 GW
10	France	3,3 GW	10	Vietnam	17,4 GW

Source: IEA PVPS

https://iea-pvps.org/wp-content/uploads/2022/04/IEA_PVPS_Snapshot_2022-vF.pdf

Off-shore Wind turbines, Blyth, U.K.

Wind Energy

Wildorado Wind Ranch-Siemens

LOCATION: Wildorado, TX
25 miles west of Amarillo in Oldham, Potter and Randall Counties

SIZE: 161 MW

COMMERCIAL OPERATIONS DATE: April 2007

UTILITY: Xcel Energy
(Southwestern Public Service Company)

TURBINE EQUIPMENT:
70 Siemens 2.3 MW Mk II

Source: http://www.nikkiphotography.com/category/environmental-issues/
http://www.cielowind.com/projects/completed-developments/wildorado-wind-ranc

Nysted Wind Farm-Siemens

Source: http://www.dongenergy.com/Nysted/EN/Pages/index.aspx

Nysted Wind Farm
Located in the Baltic Sea, it is one of the world's largest wind farms.

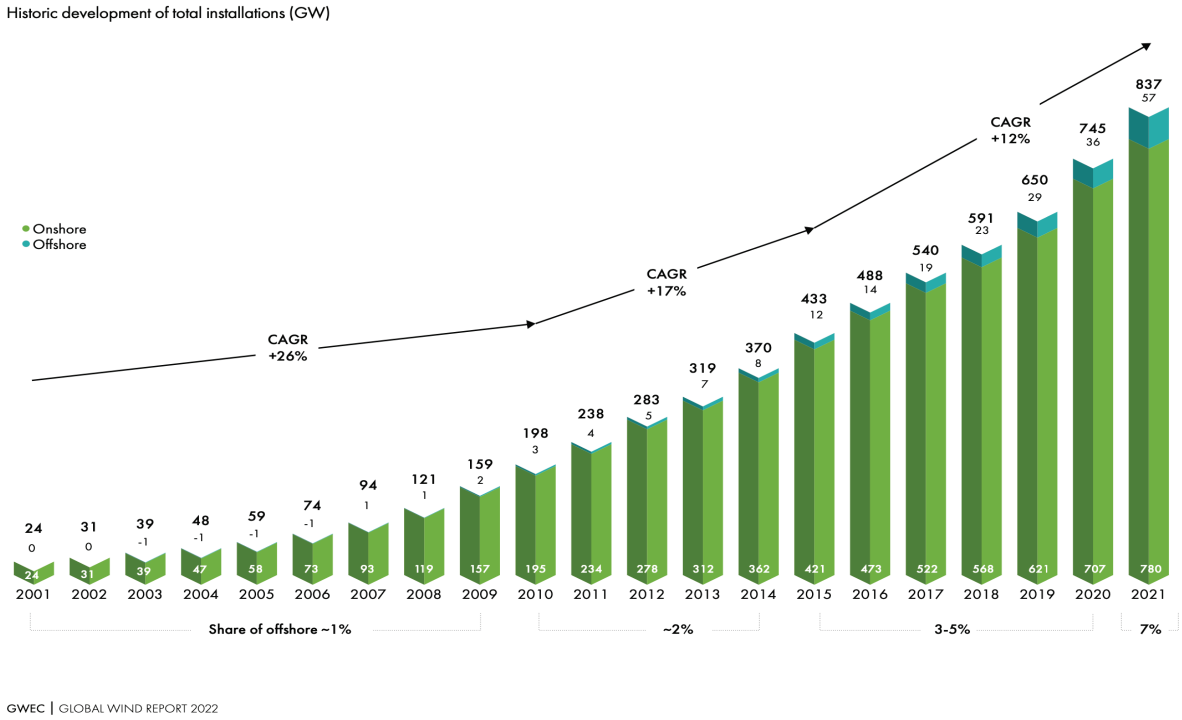
Owner: DONG Energy, Denmark (80%) and E.ON Sweden (20%).

Layout: The wind farm is made up of 8 rows of 9 turbines, of which the nearest are placed some ten kilometers offshore.

Turbine: each can generate 2.3 MW. The combined effect is 165.6 MW.

Commercially handed over:
Dec. 1st, 2004

Global Installed Wind Capacity (GW)
2001-2021 (Cumulative)

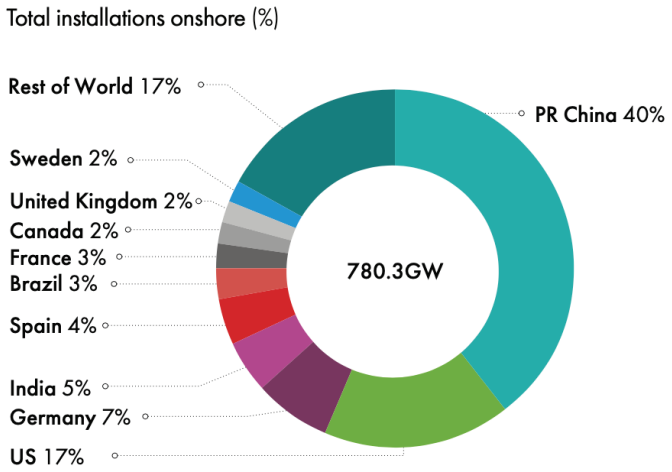


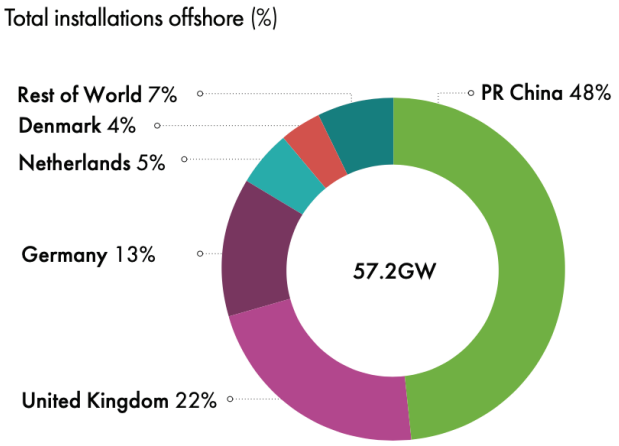
Source: GWEC Global Wind Report, 2022

CAGR – compound annual growth rate of investment

Total Onshore and Offshore Installed Wind Capacity

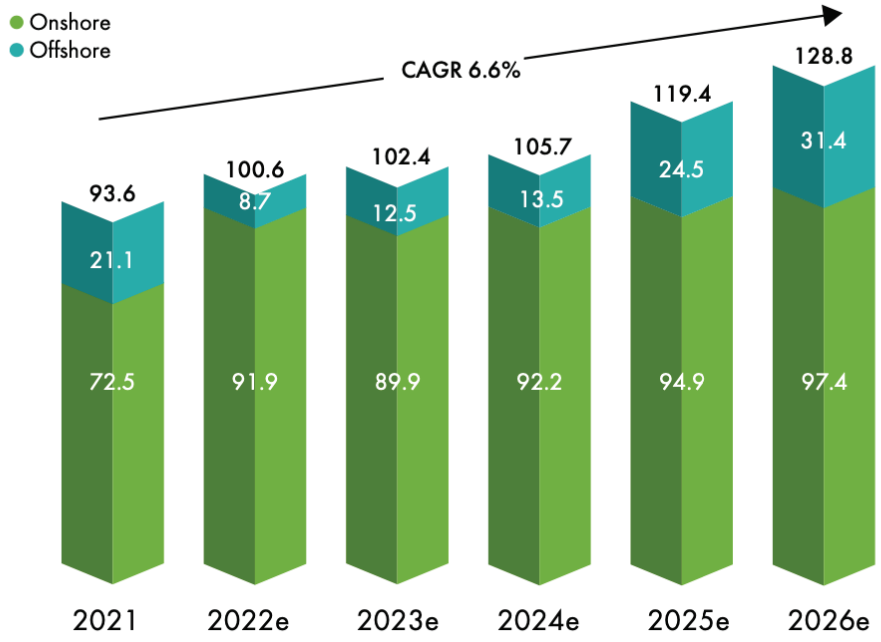
Top Ten Countries (2021)





Source: GWEC Global Wind Report, 2022

Future Wind Power New Capacity Growth (GW)
2022 - 2026



CAGR – compound annual growth rate

Source: GWEC Global Wind Report, 2019

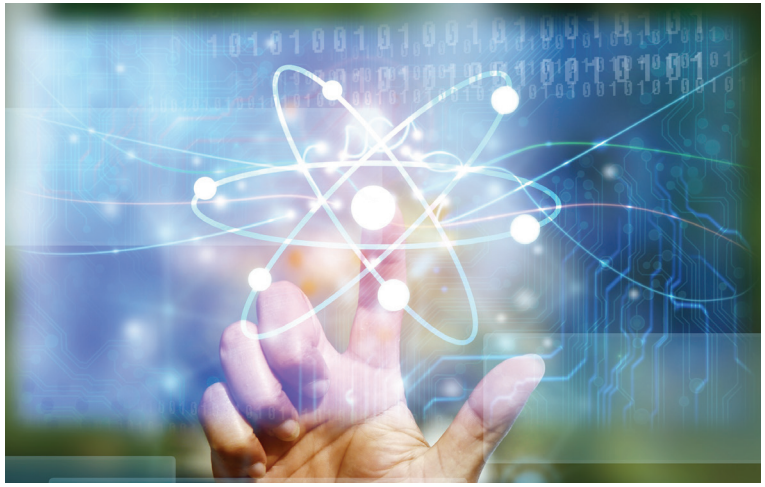
Renewable Energy Integration

Inverter-based resources pose new challenges

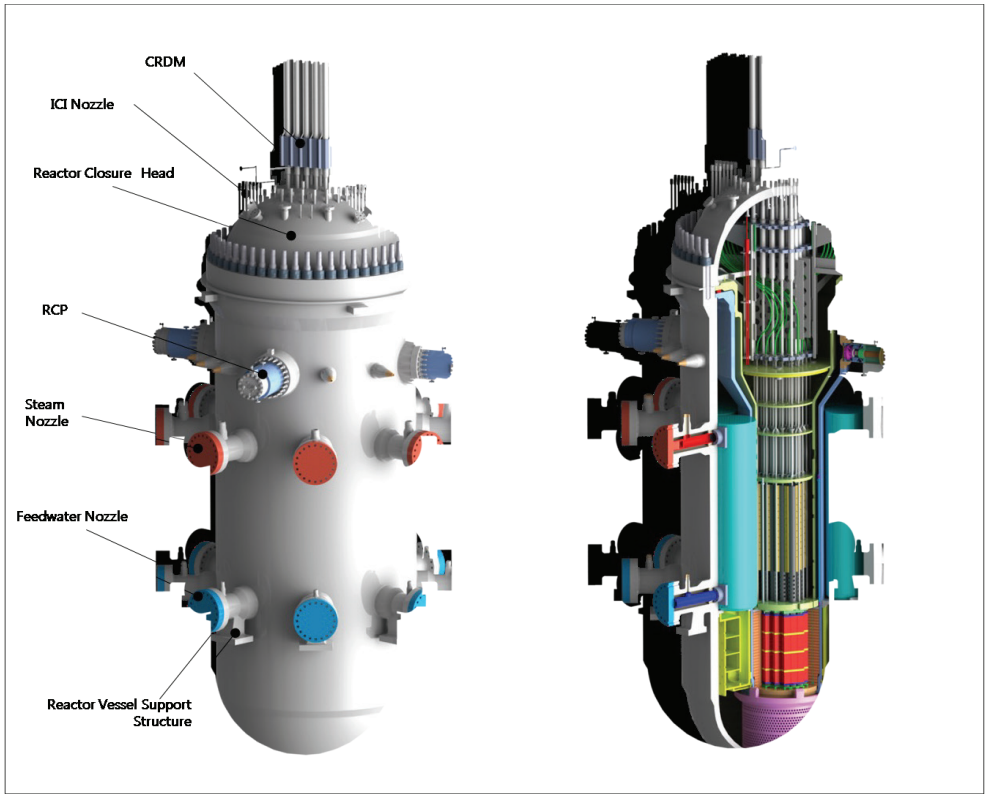
- Focus on where energy is needed most, via three core components:
  - Energy generation
  - Transmission
  - Distribution

Advanced Nuclear Technologies

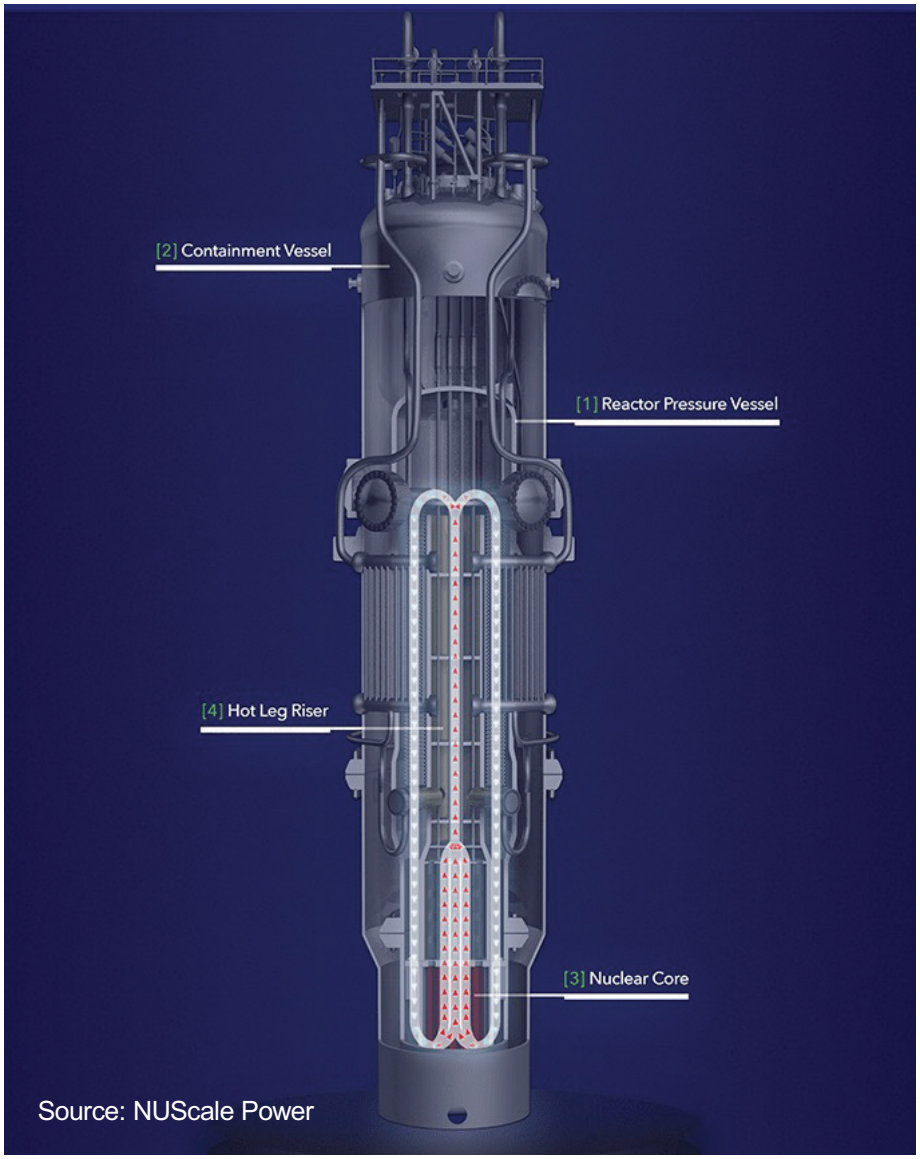
- Advanced nuclear technologies, such as small modular reactors (SMRs), can play a role
  - Smaller and can be built more quickly than more traditional nuclear reactors
- Ramping up the development of SMRs can help to produce energy when and where needed
- This energy could be integrated into existing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

- 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

Climate Change

IEEE: Enabling Innovation and Technology Solutions

IEEE Climate Change Engagement Opportunities

IEEE
Advancing Technology for Humanity

climate-change.ieee.org

IEEE's Engagement in Addressing Climate Change

Mission-based Challenge

- Pragmatic and accessible technical solutions are urgently needed to address climate change
- We, as engineers and technologists, are well and uniquely placed to provide technical solutions and offer
  a neutral space for discussion and action

What IEEE Brings to the Challenge

- Commitment to the constant pursuit of innovation and excellence for the benefit of humanity
- The technical expertise of IEEE members and volunteers from across IEEE OUs
- The power of IEEE's collaborative platforms to enable innovation with purpose
- Longer-term IEEE engagement in creating and promoting technical solutions and applications for addressing climate change

IEEE Climate Change Website

https://climate-change.ieee.org

IEEE Climate Change Collection

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Climate Change

IEEE: Enabling Innovation and Technology Solutions

Resources from IEEE Climate Change in the News Contact 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.

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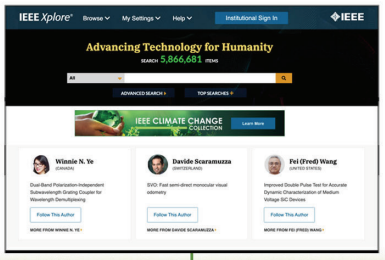

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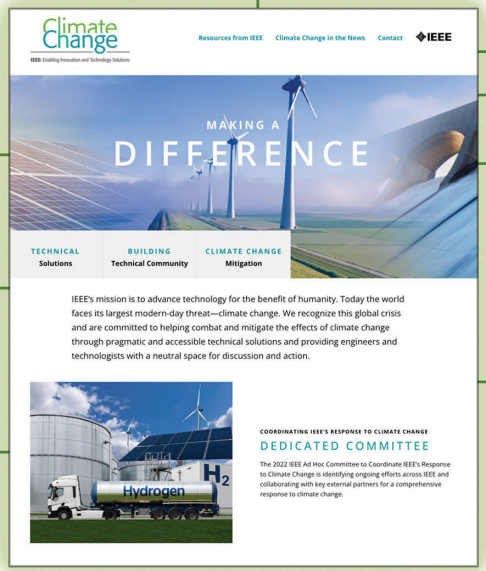

Newsletters

Climate Change
IEEE: Enabling Innovation and Technology Solutions

2022 IEEE President and CEO Social Media Channels

Follow the President's channels and stay abreast of climate change information

There are four social media channels for the IEEE President:

https://www.facebook.com/ieeepresident

https://www.instagram.com/ieeepresident/

https://www.linkedin.com/showcase/ieeepresident

https://twitter.com/ieeepresident

THANK YOU!

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