

Fighting Global Climate Change with Nuclear Power and Renewable Energy

American Nuclear Society
San Diego Section

June 19, 2024

Mehdi Sarram, President
Energy Security Consulting Group

We may have a Plan B, but Is there a Planet B?



Agenda

- Introduction
- References used
- Recent Wildfires in Canada, fires in Greece, floodings in Libya,.....
- IEA 2023 Global Energy Review
- IAEA views on nuclear energy
- World energy needs
- Carbon Footprints, Capacity Factors, Levelized Energy Cost and Mortality Rates of all energy sources
- What does the world need nuclear power and renewable energy to fight climate change io 2050?
- Discussion on nuclear power and all renewable energy source
- Walkaway Message
- QA

References

The references used are among reliable and credible sources

- UN IPCC, the Intergovernmental Panel on Climate Change is an intergovernmental body of the United Nations
- IEA, International Energy Agency, it operates within the broader framework of the OECD
- OECD-NEA, the Nuclear Energy Agency, is within the OECD
- UN – International Atomic Energy Agency (IAEA)
- REN 21, Paris based, Renewable Energy Policy Network for 21st Century
- NASA-NOAA
- WEC- World Energy Council, London based
- Statista, Hamburg based research organization
- IRENA, International Renewable Energy Agency

Goals of this presentation

- Provide the latest credible information on climate change
- Create awareness about climate change
- How do we fight problems associated with worldwide climate change?
- What are the solutions?
- Walkaway message

Problem statement

- UN: The world population will increase from about 8.1 billion in 2024 to nearly 9.7 billion just in 26 years, in 2050
- World energy consumption in 2025 will be 660 exajoules and will increase to 760 exajoules in 2050
- About 770M people had NO electricity in 2023 worldwide
- IEA Today, about 2.3 billion people worldwide - nearly one third of the global population - still cook their meals over open fires or on basic stoves, breathing in harmful smoke released from burning coal, charcoal, firewood, agricultural wastes, and animal dung
- Household air pollution, mostly from cooking smoke, is linked to around 3.7 million premature deaths a year
- The people from now to 2050 need food, electricity, shelter and clean environment

Introduction

DENIAL is NOT a Solution

Difference between opinion and fact/science-based data

- My presentation today, Not a rosy picture on our climate in 2024
- The world has been giving nearly 8 billion people many warnings in past decades about our environment
- Apparently, most of us are not listening
- The warning are about more intense and frequent hurricanes, more wildfires, more droughts, more floodings, more very high temperatures, more acidic oceans, icesheets melting,...
- Someone wisely said, Nothing gets better until it gets worse

Introduction cont, Greenland Ice Sheets melting

- Inside climate, science, Aug 2020, Greenland's Melting Ice Sheet Passed a Point of No Return in the Early 2000s
- A new study finds that the accelerating retreat and thinning of Greenland's glaciers that began 20 year ago is speeding the ice sheet toward total meltdown
- **Difference between Climate Change and Global Warming:** "Climate change" encompasses global warming but refers to the broader range of changes that are happening to our planet, including rising sea levels; shrinking mountain glaciers; ice melt in Greenland, Antarctica and the Arctic; and shifts in flower/plant blooming
- These are all consequences of warming, which is caused mainly by people burning fossil fuels and putting out heat-trapping gases into the air

Water from the Greenland ice sheet flows during unseasonably warm weather



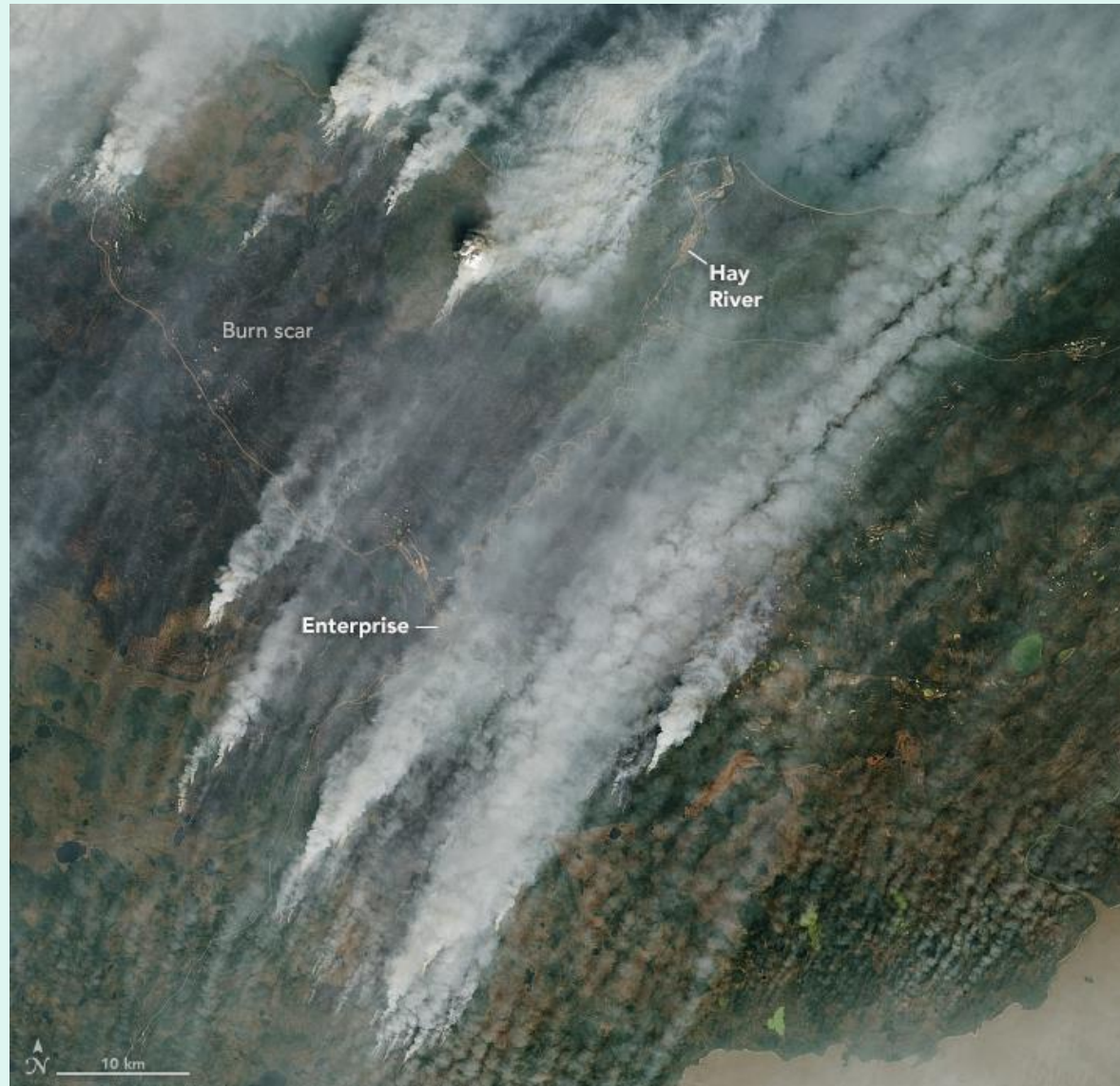
Carl Sagan warned Congress about climate change in 1985

- He was way ahead of others; this was in 1985
- “Here we are pouring enormous quantities of CO₂ and these other gases into the atmosphere every year, with hardly any concern about its long-term and global consequences.”
- It is fair to say that the level of concern has increased since Carl Sagan spoke these words in 1985, when “climate change” was not yet a household term
- “if we don’t do the right thing now, there are very serious problems that our children and grandchildren will have to face.”
- It’s impossible to know how many listeners these words convinced at the time, though they certainly seem to have stuck with a young Senator in the room by the name of Al Gore
- Al Gore was in the audience when Sagan testified in 1985, he wrote his book 22 year later in 2007

Air crews support efforts to fight the Donnie Creek wildfire, north of Fort St. John, which is now the second-largest recorded wildfire in B.C. history (B.C. Wildfire Service, 6/14-23)



2023, The same fire that overran the town of Enterprise is now threatening more towns in Canada's Northwest Territories



Smoke from Canadian wildfires obscures the skyline in Chicago as the city experienced some of the world's worst air quality on July 25, 2023



A man reacts as a wildfire burns at the Greek island of Rhodes on July 25. Wildfires raging across Greece in scorching



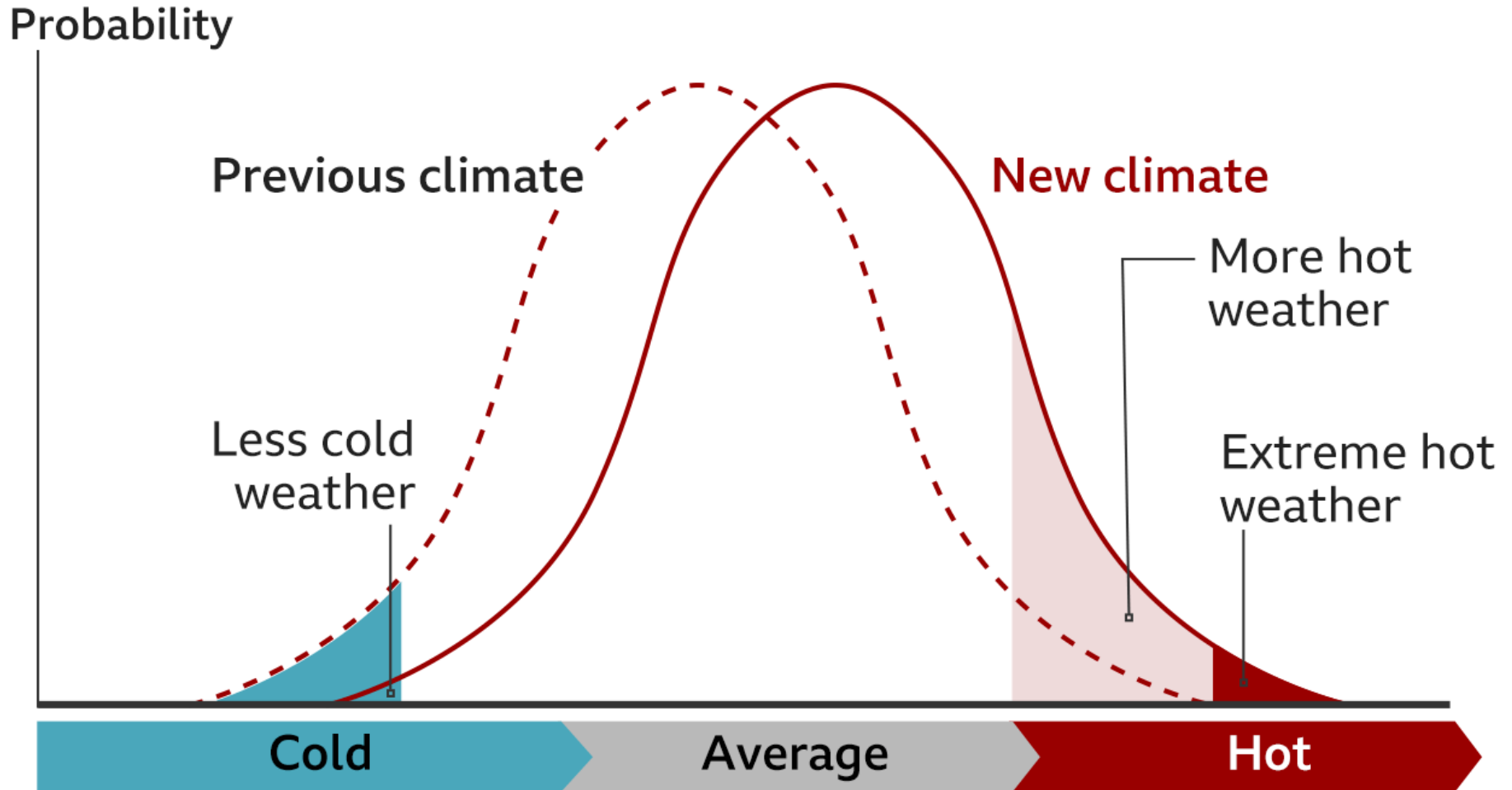
AP, 9/23 Streets a flooded after storm Danial in Marj, Libya



Heatwaves, droughts, wildfires and floods, BBC-EPA

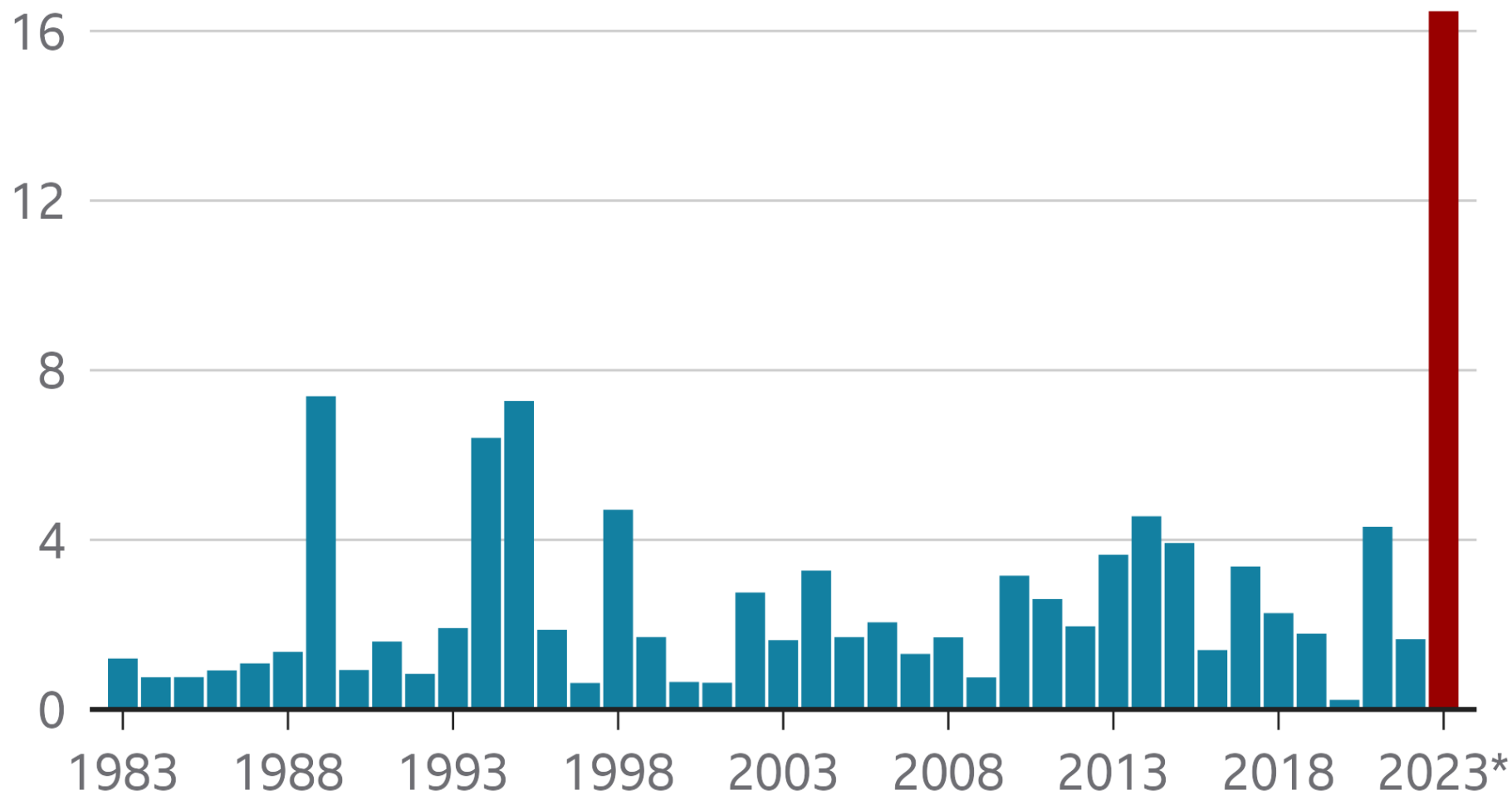
Sept 23

A small shift makes a big difference



Canada is having its worst year for wildfires

Area burned in million hectares each year since 1983



*Provisional data for 2023 up to 5 September

Source: Canadian Interagency Forest Fire Centre

United Nations, 2023

- Climate Change is the defining issue of our time, and we are at a defining moment
- From shifting weather patterns that threaten food production, to rising sea levels that increase the risk of catastrophic flooding, the impacts of climate change are global in scope and unprecedented in scale
- Without drastic action today, adapting to these impacts in the future will be more difficult and costly
- The 2023 UN Climate Change COP 28 convened from 30 November to 12 December 2023 in Dubai
- Sept 17-24, 2023, Climate Week NYC in partnership with UNGA event, large protests in NYC to save the environment
- COP 29: 2024 in Baku, Azerbaijan

IPCC

- Climate change is a threat to human well-being and planetary health
- Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850-1900 in 2011-2020
- Climate change is making the "fire weather" conditions needed for their spread more likely
- Wildfires are projected to become more frequent and intense in future globally due to the combined effects of land use and climate change in countries, and among individuals

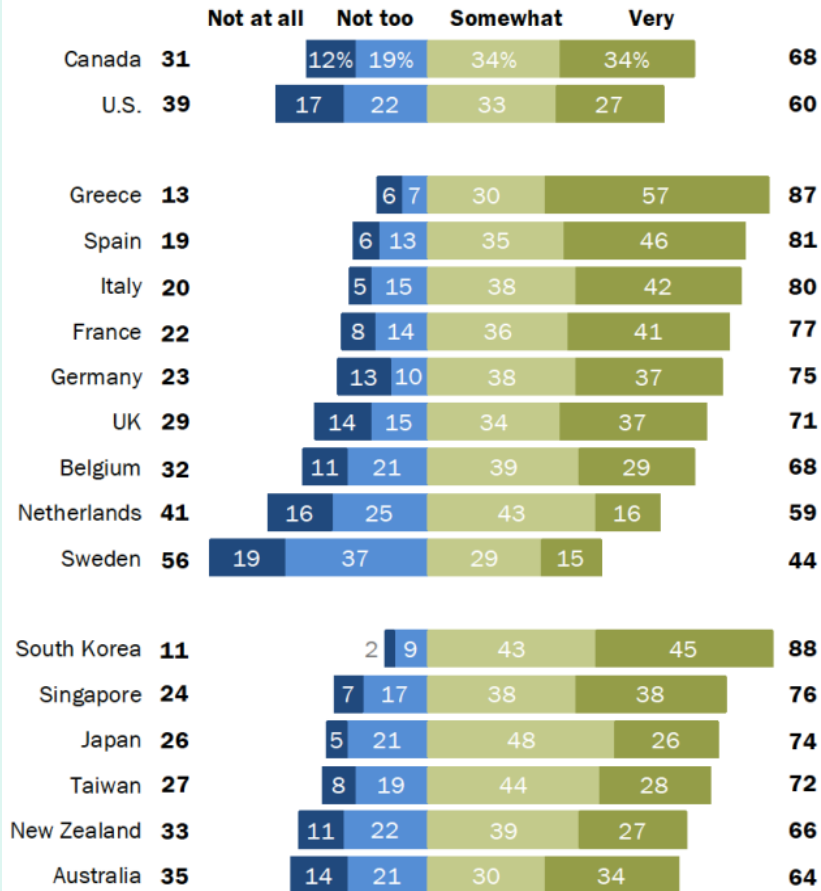
NASA 3/30/22 - Antarctic ocean currents heading for collapse-
Rapidly melting Antarctic ice is causing a dramatic slowdown in
deep ocean currents and could have a disastrous effect on the
climate, a new report warns



PEW Research, % who are concerned climate change will harm them personally during their lifetimes, Spring 2021

Many are concerned climate change will personally harm them during their lifetimes

% who are ___ concerned that global climate change will harm them personally at some point in their lifetime



Note: Those who did not answer not shown.

Source: Spring 2021 Global Attitudes Survey, Q31.

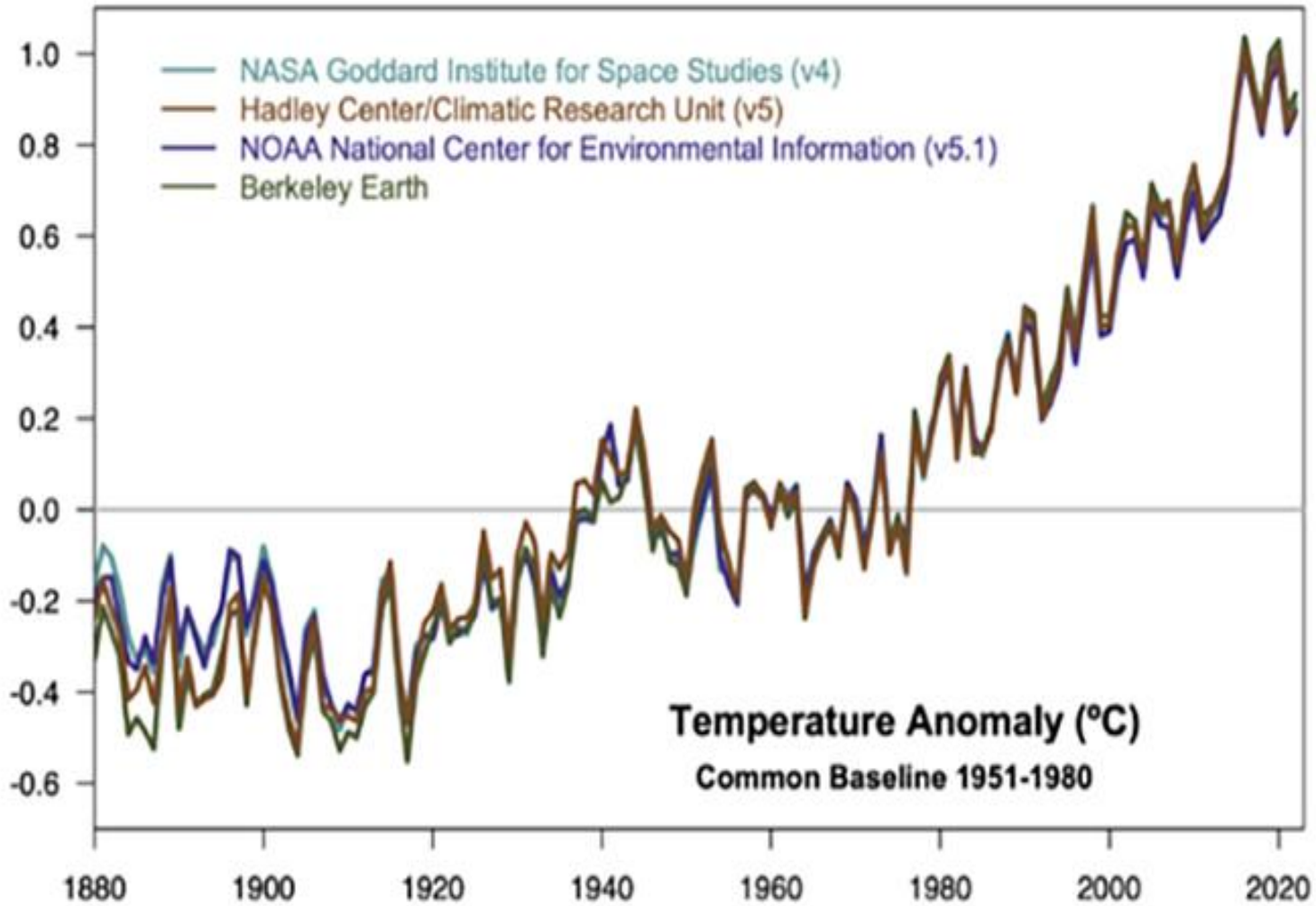
"In Response to Climate Change, Citizens in Advanced Economies Are Willing To Alter How They Live and Work"

PEW RESEARCH CENTER

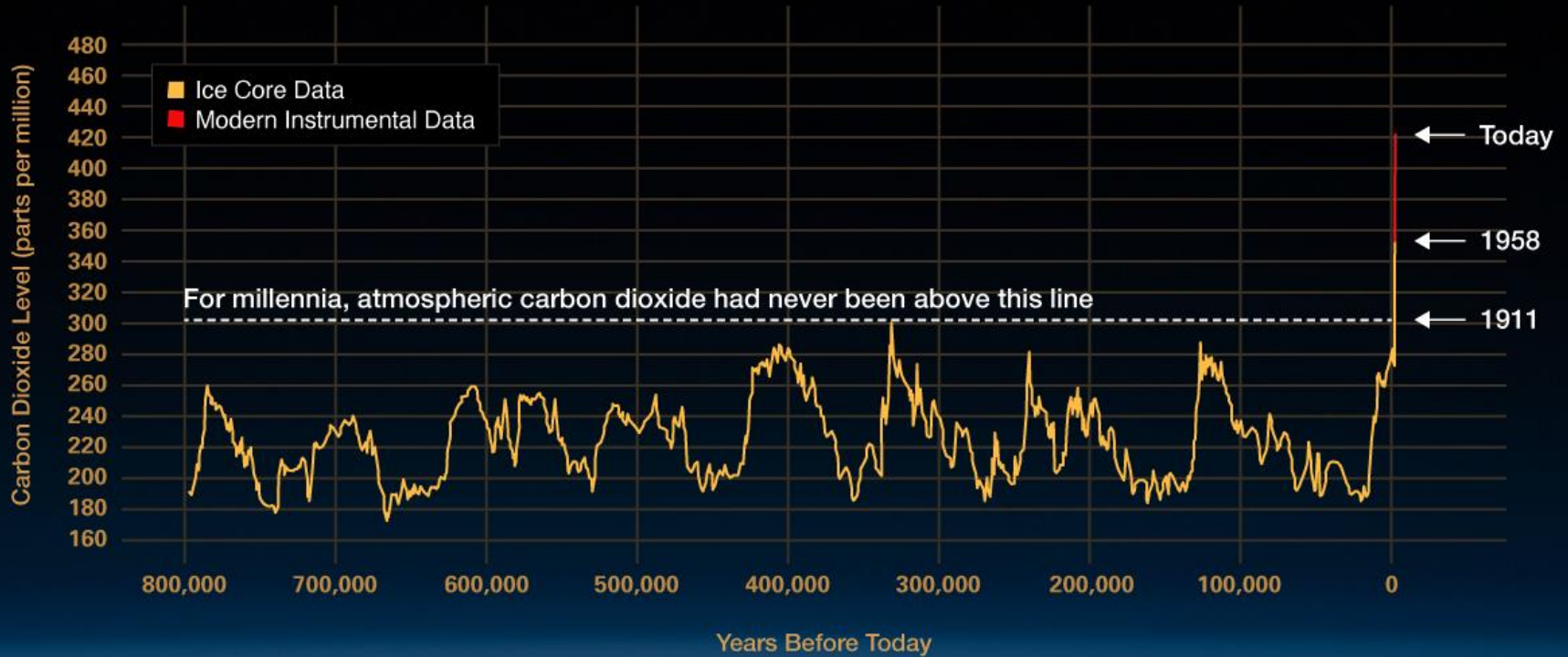
NASA Data

- **NASA Confirms July 2023 is Warmest Month on Record**
- How do we know climate change is REAL?
- There is an unequivocal evidence that the Earth is warming at an unprecedented rate
- **Human activity is the main cause**
- From global temperature rise to melting ice sheets, the evidence of a warming planet abounds

NASA Data



NASA Data



US Pentagon view on climate change

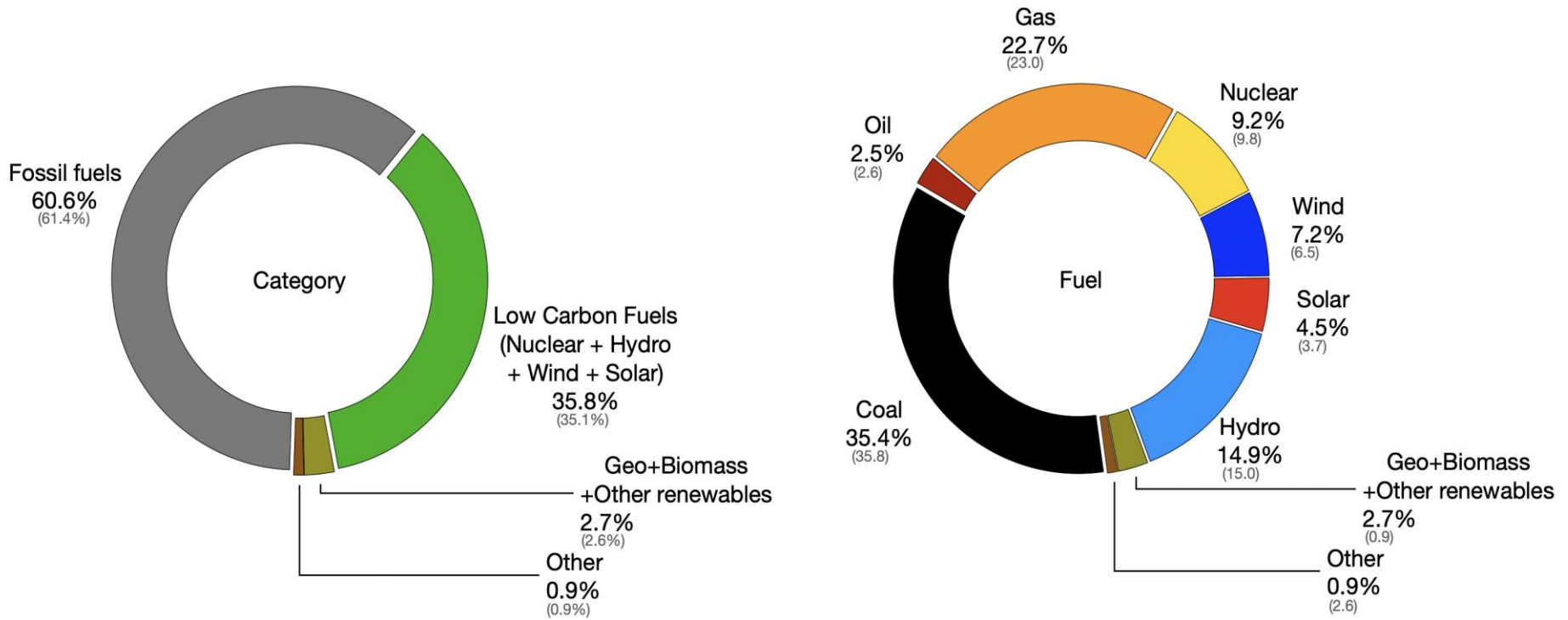
- For the Pentagon, there is no debate about whether climate change exists, but how gravely it will magnify existing threats to security and destabilize human life
- The military has for years acknowledged that climate change is real, creating conditions so extreme that some military officials fear **future climate wars**
- **At the same time, the military forces and DOD agencies are the largest single energy consumer in the United States and the world's largest institutional greenhouse gas emitter (The MIT Press)**

Toronto, Canada Bylaw, you get fined if you idle your car

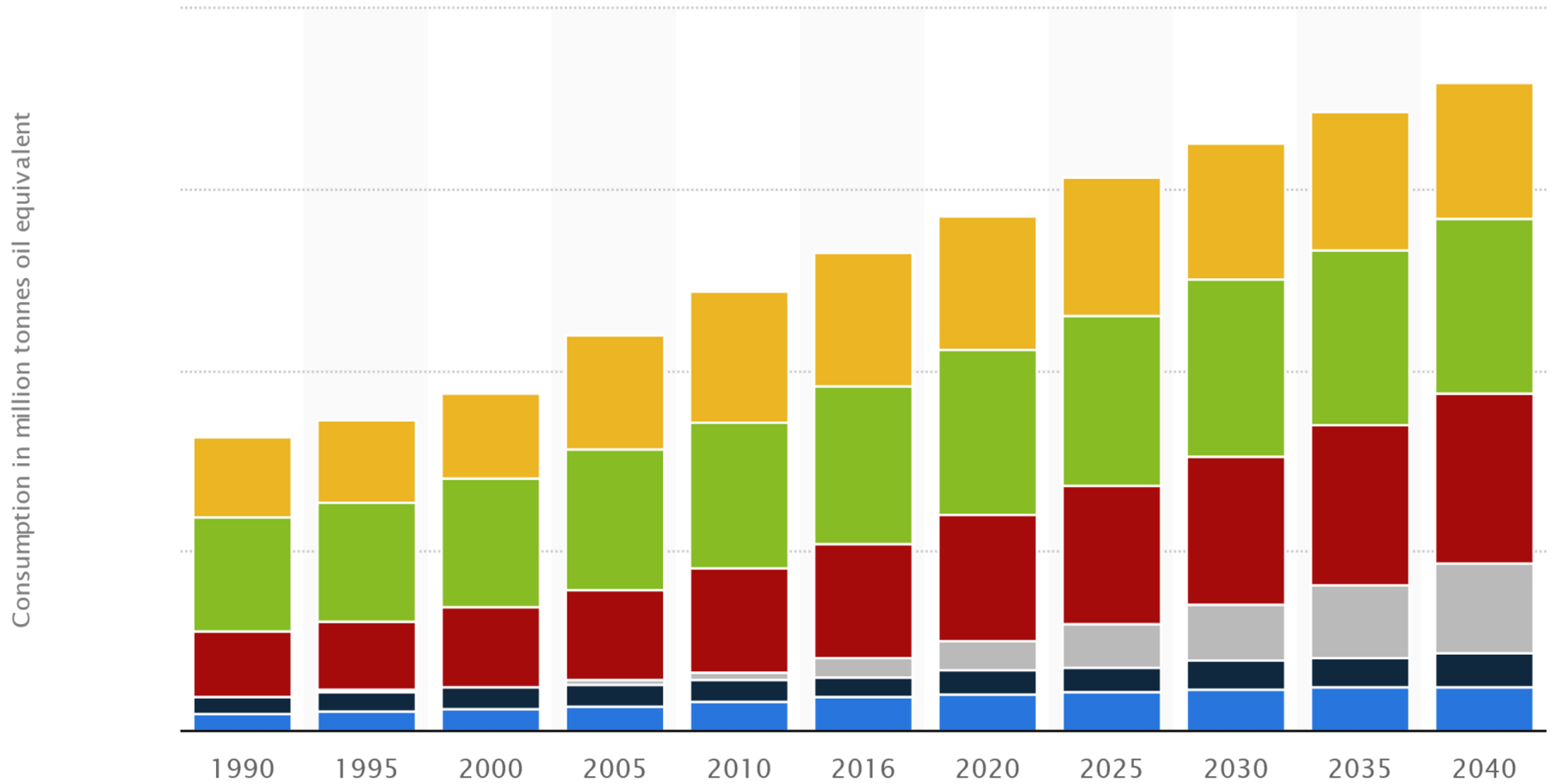


World electricity generation 2022, World Energy Data

World Electricity Generation 2022
 Grey values shown in brackets are 2021 values

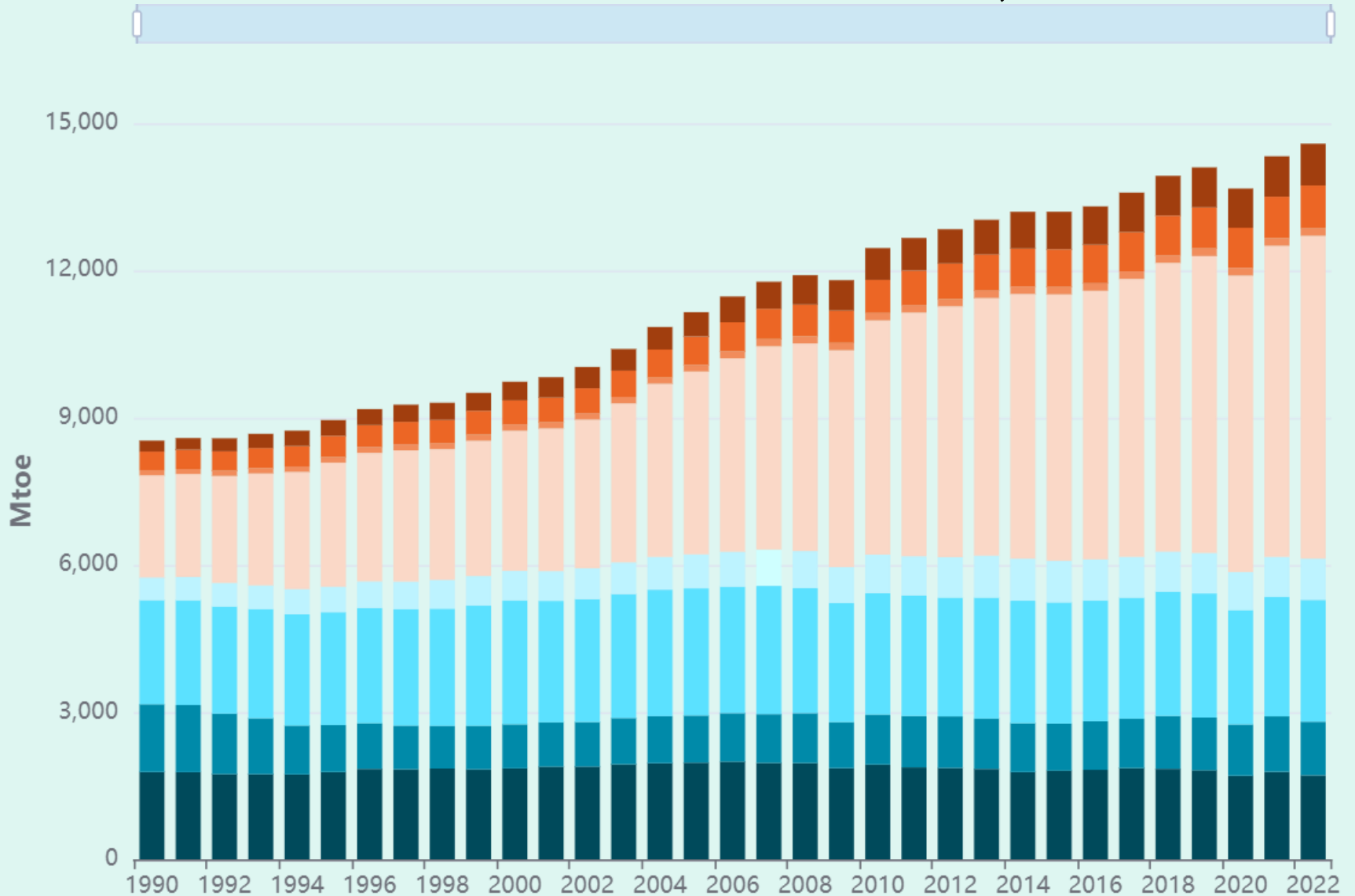


Projected global energy consumption from 1990 to 2040, Statista

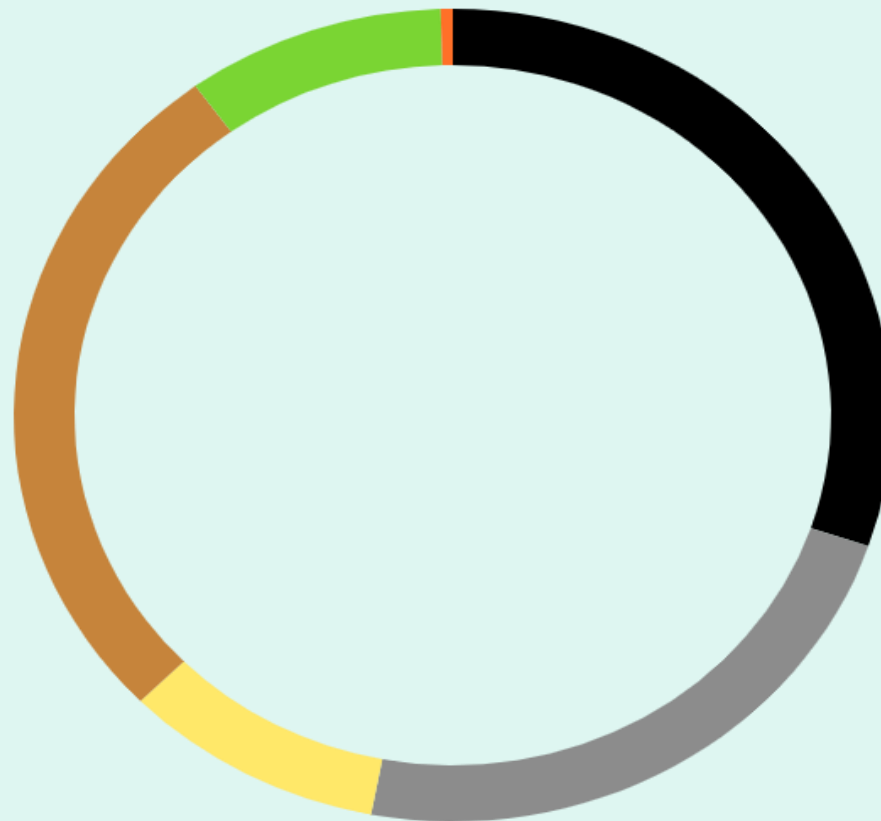


- Hydroelectricity
- Nuclear energy
- Renewable energy**
- Natural gas
- Total liquids*
- Coal

Breakdown by energy (2022) – Mtoe, Global Energy 2023 Edition, SEE next slide

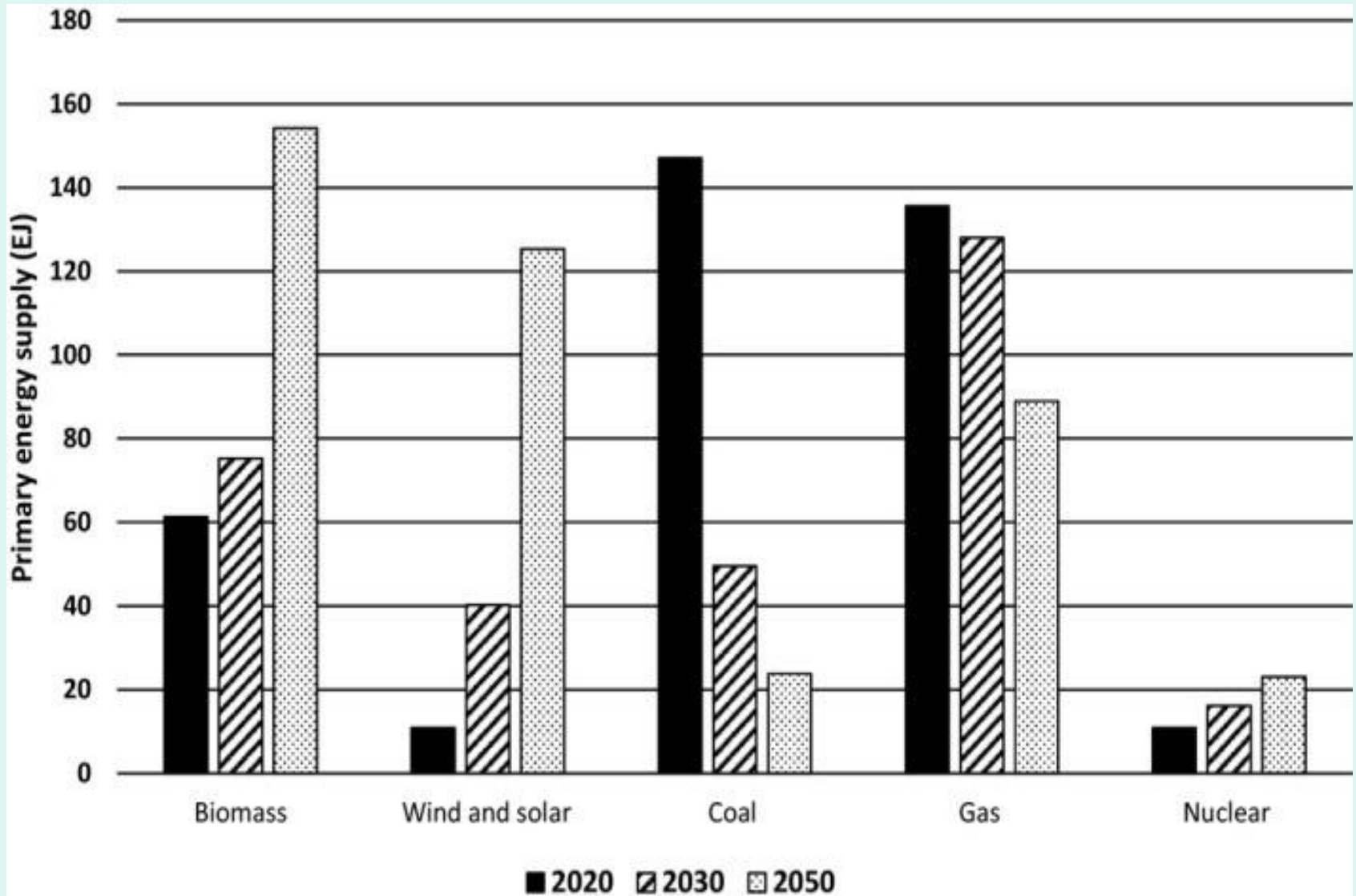


2023 Energy by source, previous slide



Oil Gas Electricity Coal
Biomass Heat

Source NREL (National Renewable Energy Laboratory),
GOCO, unit EJ=Exa Joule, 1E18



CO2 Footprint gCO2/KWh

Energy source

- **Coal** ~820
- **Oil** ~750
- **Natural gas** ~490
- **Biomass** ~230
- **Solar Photovoltaics, roof** ~38-48
- **Solar concentrated** ~27
- **Wave/tidal** ~25-50
- **Hydroelectric** ~24
- **Geothermal** ~38
- **Wind onshore** ~11
- **Wind offshore** ~12
- **Nuclear** ~5-10

Note: IPCC 2022 data

Different references may have slightly different data

**Statista 2021 - Capacity Factors, all energy sources,
other references may have slightly different data**

Energy Source	CF %
Biomass	63
Wind	35
Solar PV	27
Solar CSP	21
Tidal-Ocean	20-35
Geothermal	71
Hydro	27
Coal	49
Gas	62
Nuclear, 60 year life	93

Levelized Energy Cost of Electricity, 2023,

Other sources may provide slightly difference data

• Source	Ave \$/MWh
• Wind offshore	72 - 140
• Wind on shore	42 - 114
• Natural gas	61 - 102
• Solar PV	117 - 282
• IGCC coal	116 integrated gasification comb. cycle
• Biomass	101
• Advanced nuclear	141 -221
• Hydro	84
• Wind onshore	24 - 75
• Nat gas Advanced CC	73
• Geothermal	61 - 102

LEC = Average Levelized Energy Cost (lifetime levelized electricity generation cost)

I_t = Investment expenditures in the year t

M_t = Operations and maintenance expenditures in the year t

F_t = Fuel expenditures in the year t

E_t = Electricity generation in the year t

r = Discount rate

n = Life of the system, **nuclear=60 y, fossil=40 y**

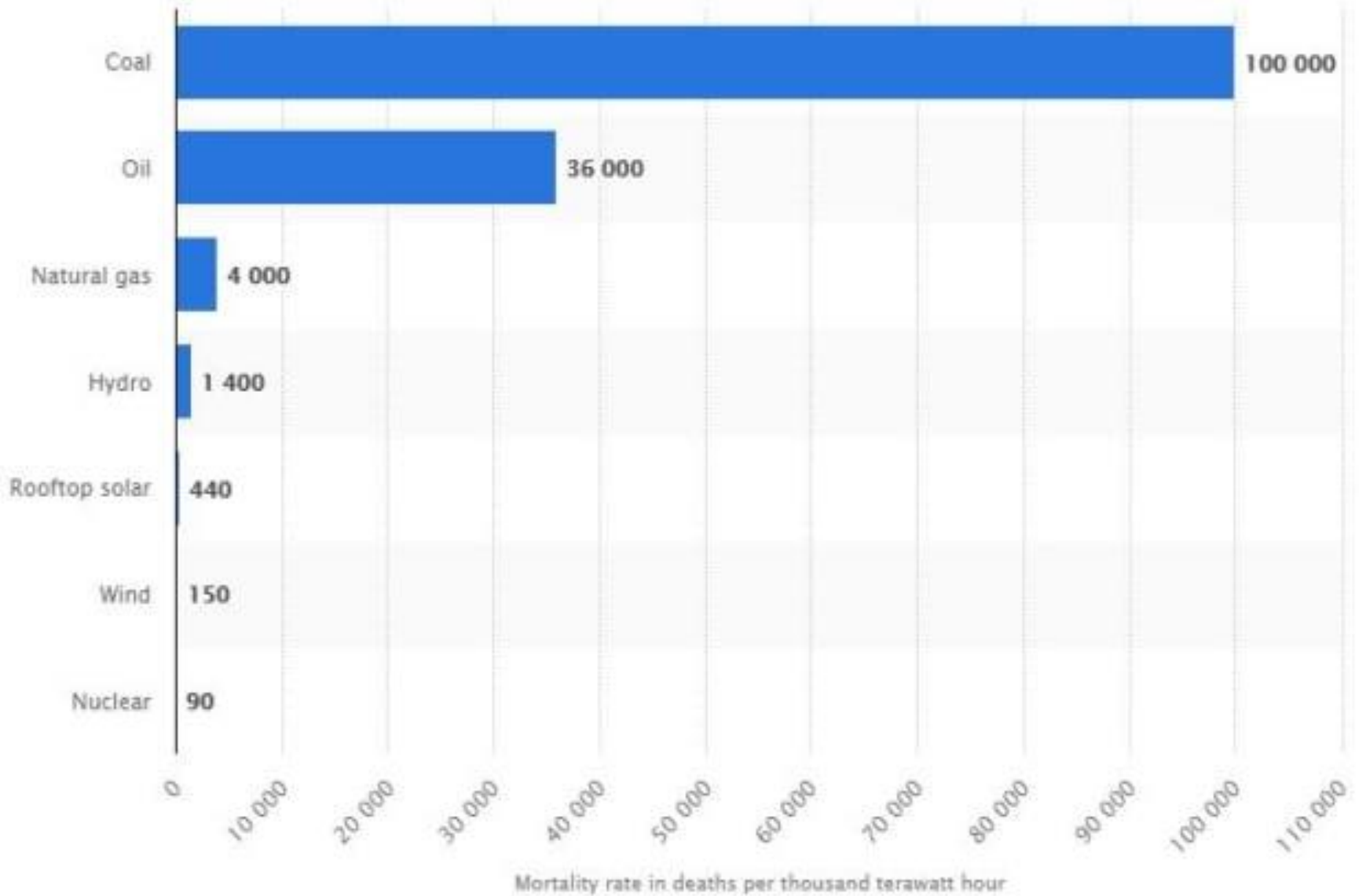
$$\text{LEC} = \frac{\sum_{t=1}^n \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^n \frac{E_t}{(1+r)^t}}$$

Statista - Mortality rate from accidents and air pollution per unit of electricity worldwide, by energy source in Deaths per thousand - Terawatt hour

Source	Deaths per 1E12
Brown Coal	72.7
Coal	18.4
Natural Gas	2.8
Hydro	1.3
Wind	0.04
Nuclear	0.02
Solar	0.02

Note: When we choose an energy source, we NEED to consider all its parameters: Carbon footprint, LEC, CF and mortality rate

Mortality rate



Statista - Distribution of electricity generation worldwide in 2022, by energy source

Source	Percent
Coal	35.8
Nat Gas	22.2
Hydro	15.2
Nuclear	9.2
Wind	7.5
Solar	4.5
Other fossil	3
Bioenergy	2.4
Other renewables	0.4

Air pollution in world

- Fossil fuels much more deadly
- Coal is responsible for over 800,000 premature deaths per year globally and many millions more serious and minor illnesses
- In China alone, around 670,000 people die prematurely per year as a result of coal-related air pollution
- Air pollution caused by the burning of fossil fuels such as coal and oil was responsible for 8.7M deaths globally in 2018, some report 8M

EU

There is NO future with fossil fuels

Recent Libya flooding linked to climate change

- Scientists have predicted for decades that burning fossil fuels would push average temperatures ever higher and conjure dangerous extremes, such as those seen in the UK's current tropical heat
- A new branch of science, [called extreme event attribution](#), that has emerged in the past 15 years connects global warming to severe episodes of weather with a much greater level of specificity
- Many individual heat spells, storms, floods, droughts and wildfires are now routinely tied to climate change

Solutions: Use Nuclear Power and Renewables

- How do we reduce world carbon emissions by 2050?
- Renewable energy sources and nuclear power offer solutions
- Wind and nuclear power have the lowest carbon foot print of all energy sources
- **A KWe from coal produces about 170 times more CO2 than nuclear**
- Nuclear energy has the LOWEST mortality rate among ALL energy sources, including renewables

2 billion people live without access to adequate sanitation



UN 2023: 1 in 4 people around the world do not have clean drinking water



Global water electricity shortage problems

- IEA: today About 770M people have NO electricity (was 1.3B in 2010), this is REAL progress update
- 2.3 billion people live in water-stressed countries, of which 733 million live in high and critically water-stressed countries (UN-Water 2021)
- Today, 1.4 billion people – including 450 million children – live in areas of high or extremely high-water vulnerability (UNICEF-2021)
- Nearly half the global population are already living in potential water scarce areas at least one month per year and this could increase to some 4.8–5.7 billion in 2050

How Can Nuclear Power Combat Climate Change?

- To limit the impacts of climate change, the world must rapidly reduce its dependency on fossil fuels to reduce greenhouse gas emissions
- Nuclear energy can be deployed on a large scale at the timescale required, supplying the world with clean, reliable, and affordable electricity
- Nuclear power plants produce no greenhouse gas emissions and over the course of its life-cycle, nuclear produces about the same amount of carbon dioxide-equivalent emissions as wind, and one-third of the emissions as compared with solar
- IEA- Nuclear power and hydropower form the backbone of low-carbon electricity generation
- Over the past 50 years, the use of nuclear power has reduced CO₂ emissions by over 60 gigatonnes

WHY the world needs Nuclear Power and renewables to fight climate change

- First, Nuclear power
- With what I presented; now why do we need nuclear power to fight climate change?
- Lowest mortality rate
- The safest energy industry *despite the accidents*
- Highest Capacity Factor among all energy sources
- Nuclear plants work under the worst conditions, recent polar vortex, providing clean electricity
- **We can fight climate change by maximizing nuclear power and ALL renewable energy sources**

IAEA Nuclear power

- As of May 2023, there were 436 nuclear power reactors in operation across 32 countries
- In the high case, it is assumed that the operating life of several nuclear power reactors scheduled for retirement will be extended such that only about 8% of the 2021 nuclear electrical generating capacity is retired by 2030
- This is expected to result in net capacity additions (newly installed less retired) of about 90 GW(e) by 2030 and more than 390 GW(e) over the subsequent 20 years
- In the low case, it is assumed that about 18% of existing nuclear power reactors will be retired by 2030, while new reactors will add about 60 GW(e) of capacity
- Between 2030 and 2050 it is expected that capacity additions of new reactors will slightly exceed retirements

IAEA projections nuclear power to 2050

- The IAEA's latest projections
- For the first time since the Fukushima Daiichi accident a decade ago, the IAEA has revised up its projections of the potential growth of nuclear power capacity for electricity generation during the coming decades
- The world nuclear generating capacity will double to 792,000 Mwe (about 800 nuclear plants) by 2050 from 393 GWe in 2020 under the high case scenario
- According to IAEA, the nuclear capacity could more than double by 2050
- Nuclear's share of global electricity would increase from the current level of about ~10-11% to ~13% by 2050
- Question: why doubling the world nuclear capacity in 2050 does not increase the percent share on nuclear significantly

Leaders in nuclear power

- The US still leads in terms of capacity in nuclear operation, with about 95,500 MW (92 plants in 28 States)
- France follows at 62,000 MW (58 plants) with China placing third at 45,000 MW (47 plants), then then Russia and South Korea,...
- But while the U.S. is decommissioning reactors with few new ones in the pipeline to replace them
- More than 90 nuclear plants in the planning stages in the world
- Example: UAE, not an advanced nation, just made its 1,400 MWe plant critical in Aug 20, South Korea design, took billions of dollars and YES, Koreans built the plants, a \$25B project

Why some people opposed to nuclear power?

- The first experience for most people with nuclear power was nuclear weapons on Japan in 1945
- Other issues are **nuclear waste disposal**, cost (today about \$5-7B for a 1000 MWe nuclear plant)
- Consider the cost for Vogtle 3-4 AP100 cost overruns
- Licensing and construction time
- Manpower, a nation with nuclear power needs hundreds of high-level trained engineers and technicians to operate the plant, it takes years to license a nuclear plant operator
- Accidents in Chernobyl, TMI and Fukushima scare people
- The major role of antinuclear organizations

More from IEA on all energy sources

- Renewables are set to provide more than one-third of total electricity generation globally by early 2025, overtaking coal
- The share of renewables in electricity generation is forecast to rise from 30% in 2023 to 37% in 2026
- The rapid growth of renewables, supported by rising nuclear generation, is set to displace global coal-fired generation, which is forecast to fall by an average of 1.7% annually through 2026
- At the COP28 climate change conference that concluded in December 2023, more than 20 countries signed a joint declaration to triple nuclear power capacity by 2050
- Momentum is also growing behind small modular reactor (SMR) technology. The technology's development and deployment remains modest and is not without its difficulties, but R&D is starting to pick up

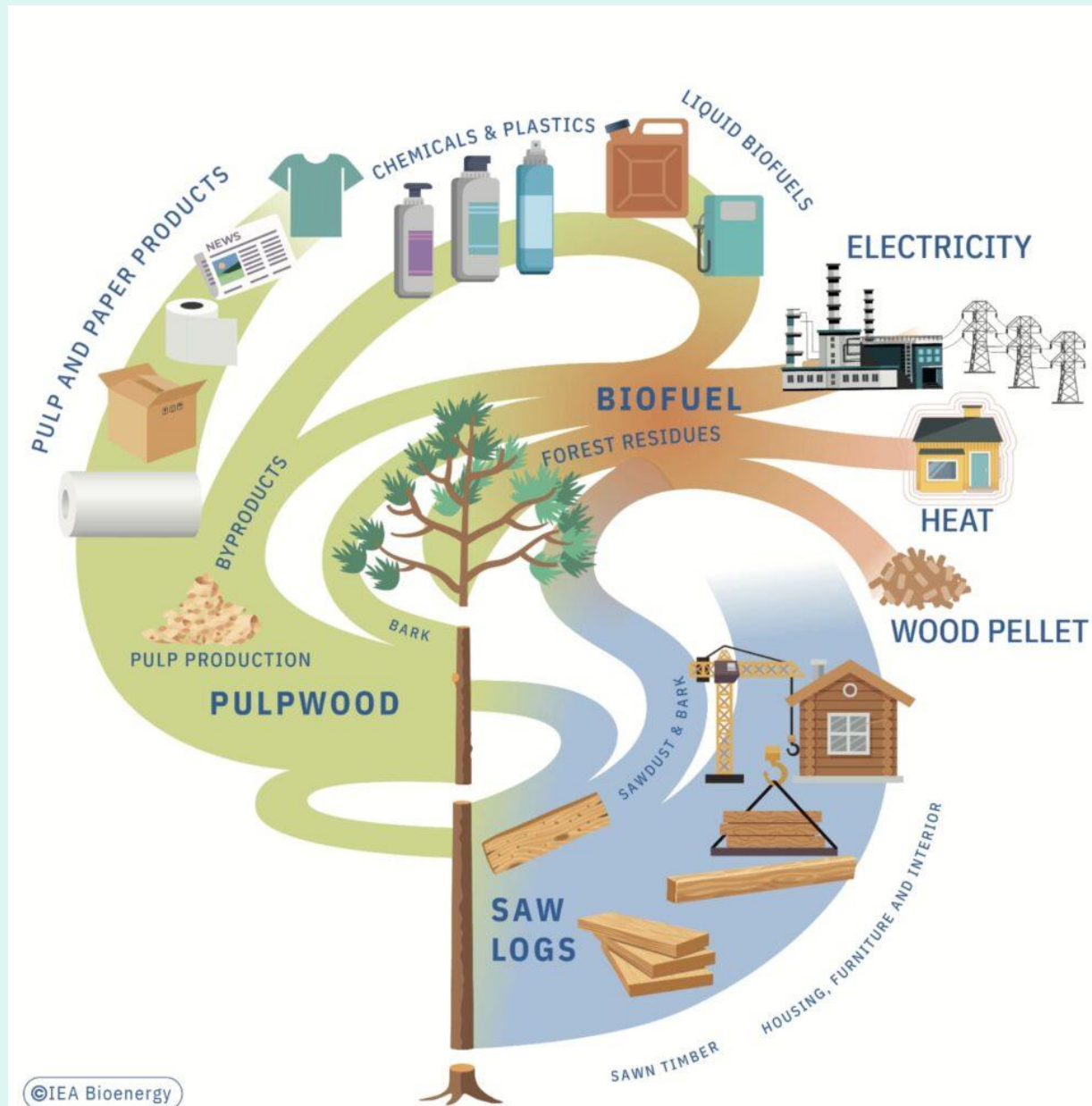
More from IEA on all energy sources

- Global hydropower generation declined in 2023 due to weather impacts such as droughts, below average rainfall and early snowmelts in numerous regions
- According to the IAEA's high case projection, nuclear energy could contribute about 12% of global electricity by 2050, up from 11% in last year's 2050 high case projections. Nuclear power generated around 10% of the world's electricity in 2020
- To reach net-zero emissions, nuclear power capacity needs to double to 812 gigawatts (GW) by 2050 from 413 GW early this year, the IEA said in a report
- As of May 2023, there were 436 nuclear power reactors in operation across 32 countries. Around 20 percent of them were in the United States, the largest nuclear power generating country in the world, followed by China, France, and Russia

Renewables Energy Sources - Bioenergy

- IEA - Bioenergy, an important element in addressing climate change, securing energy supply, and providing income through regional biomass-supply chains, is today the largest source of renewable energy
- This traditional use of biomass is problematic, as open fires are inefficient and expose people (particularly women and children) to emissions of harmful air pollutants, which can lead to respiratory disease
- There is consensus that the traditional use of biomass should be phased out as soon as possible
- Nearly two-thirds of biofuel demand growth will occur in emerging economies, primarily India, Brazil and Indonesia

No part of a tree is wasted: how sustainable bioenergy utilizes wood residues in a bioeconomy



Renewables Energy Sources - **Bioenergy**

- About two-thirds of bioenergy supply is used in developing countries for **cooking and heating**
- Using biomass and replanting helps close CO2 cycle, **if no replanting, then burning of plants in biomass process emits CO2 to our environment**
- Top nations using biomass for energy are: Brazil, Indonesia, China, The US, Germany
- California biomass energy industry currently consists of 28 plants
- California's biomass energy industry currently consists of 29 operating power plants located throughout the state, representing a total of 600 MW of generating capacity. These facilities convert more than 6.4 million tons/year of biomass into electricity

Wind energy

- The cumulative capacity of installed wind power worldwide amounted to approximately 1,021 gigawatts in 2023
- Onshore wind power accounted for the majority of total wind power capacity, at about 946 gigawatts that year.
- 2023-VESTAS Denmark, received an order for six V136-4.5 MW wind turbines, includes supply and commissioning of the turbines
- Larger wind turbines are enabling more efficient energy production and lower electricity costs, paving the way to achieve more than 1,000 gigawatts of cumulative offshore wind capacity by 2050 to meet the Paris Agreement
- Issues with wind energy: noise, killing birds, impact on the patterns of surface air temperatures, ice formed on blades can cause damage when detached. Need a volunteer



Solar PV

- IEA, Solar photovoltaic could provide up to 16% of world total electricity demand in 2050
- Global solar PV manufacturing capacity has increasingly moved from Europe, Japan and the United States to China over the last decade
- China has invested over USD 50 billion in new PV supply capacity – ten times more than Europe – and created more than 300 000 manufacturing jobs across the solar PV value chain since 2011
- Today, electricity-intensive solar PV manufacturing is mostly powered by fossil fuels, but solar panels only need to operate for 4-8 months to offset their manufacturing emissions
- During QA, can discuss electric cars and bikes

Concentrating Solar Power (CSP)

- IEA, electricity from CSP could provide up to 11 % of world demand by 2050
- Latest CSP in Construction: 2023 (three projects)
- #1: Huidong New Energy 110 MW Beam-down Tower CSP,
#2: Cosin Solar: Jinta Zhongguang 100 MW Tower CSP
- #3: CEIC/ Lanzhou Dacheng's 100 MW Molten Salts
- UAE: Latest CSP in Construction: 2023 DEWA "NOOR" 700 MW Tower & Trough CSP project Solar
- Morocco: 2018, 550 MWe
- S Africa 2023, 100 Mwe
- Chile, 2022, 110 MWe
- Spain, Australia, Israel (230 MWe), US, Mexico, India, Brazil, Egypt, Italy, Algeria, Iran (Yazd, 2010, 64 MWe),...

Tidal Ocean

- Ocean Energy and Net Zero: An International Roadmap to Develop 300GW of Ocean Energy by 2050
- IEA estimates that tidal ocean power could produce 8000-80.000 GWh /year
- Sihwa Lake Tidal Power Station, located in South Korea, is the world's largest tidal power installation, with a total power output capacity of 511 MW
- Next to France is UK with 139 MW, Canada with 40 MW
- New Record Tidal Wave Project: is located in waters off the north coast of Scotland, sent more than 17.5 GWh of renewable energy to the NATIONAL grid in 2019
-

Tidal-ocean

- Tidal power can have effects on marine life. The turbines can accidentally kill swimming sea life with the rotating blades,

Top tidal-ocean power plants

Source: National Energy Board of Canada

- S Korea: 511 MW
- France: 246 MW
- UK: 139 MW
- Canada: 40 MW
- Belgium: 20 MW
- Sweden: 11 MW
- **See next slide**

Record Tidal Wave Project, north coast of Scotland



SeaGen at Strangford Lough, Northern Ireland



Geothermal

- For about every 328 feet below the Earth's crust the temperature of the rock increases about 5.4 F
- Geothermal currently supplies about 0.34% of global electricity generation
- It is predicted to grow to about 3% by 2050
- Installed capacity for geothermal energy in 2023 was 14.9 GW

Geothermal cont

- United States* – 3,794 MW
- Indonesia – 2,356 MW – additions at Sorik Marapi, Sokoria and a small binary plant at Lahendong
- Philippines – 1,935 MW – a small binary plant was added
- Turkey – 1,682 MW – we adapted/ corrected our numbers, there were no additions in 2022
- New Zealand – 1,037 MW – no changes
- Mexico – 962.7 MW – no change
- Kenya – 944 MW – addition of the 83.3 MW Olkaria I Unit 6 (with new additions in construction, the country should soon join the Geothermal GW Country Club)
- Italy – 944 MW – no change
- Iceland – 754 MW
- Japan – 621 MW – smaller scale additions and corrections of numbers (of previously unrecorded numbers)

Krafla geothermal power plant in Iceland



Hydro

- Hydro power has played and will play a significant role in world electricity supply by 2050
- Current hydro power provides about 20% of world electricity with about 850-900 GW installed capacity
- Almost three-quarters of global hydropower capacity additions in 2022 happened in China, 24 GW
- Europe commissioned almost 2 GW of pumped storage hydropower capacity in 2022
- Currently, only **three facilities over 10 GW are in operation worldwide:**
- **Three Gorges Dam (China) at 22.5 GW**
- **Itaipu Dam (Brazil) at 14 GW**
- **Guri Dam (Venezuela) at 10.2 GW**

Walk away message

- At the rate, the world population is increasing (8.1B in 2024 to 9.7B in 2050), **the supply of all nuclear power and all renewable energy sources possibly CANNOT meet the demand worldwide**
- To meet the world demand by 2050, we need a balanced and realistic portfolio of ALL energy sources:
 - **Maximize the number of nuclear plants (new generation)**
 - **Maximize all renewable energy sources**
 - **Minimize use of fossil fuels, sadly we still need fossil fuels to 2050**
 - **And Conservation by the rich nations**
- **Become a believer in climate change**, share with others, especially the young generation who will face climate change problems in 2050

Walk away message

- **CONSERVATION, EVERYONE has responsibility to protect the environment by reducing one's carbon footprint**

Country/Continent	% population of world	% energy use
US	~4	~16
Europe	~9.6	~12.4
China	~18.8	~22

- **I CANNOT expect the nearly 770 million people in the world without electricity to conserve electricity, they cannot conserve what they do NOT have**
- The world needs nuclear power to meet climate change commitments
- I am optimistic the world young generation will find solutions for climate change by 2050 or sooner
- And, as is always the case, the poor and vulnerable are the first to suffer and the worst hit

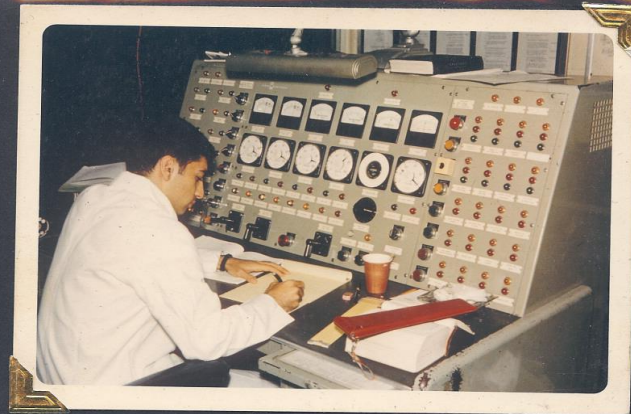
Final Note

- **Climate Change is Real and is here**
- **Science tells us WE have to change our way of life**
- **WE are all in this TOGETHER**

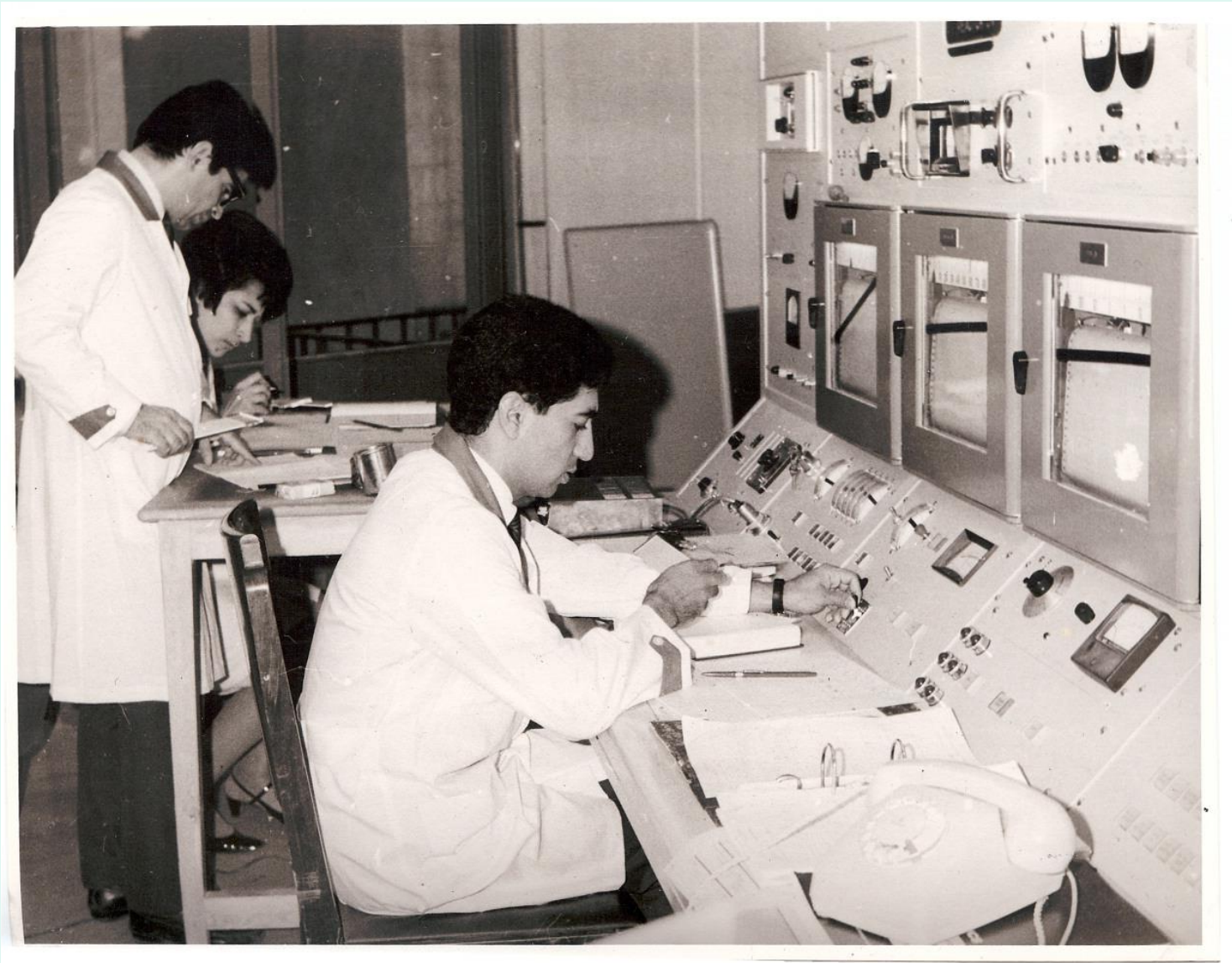
Your speaker is also Real

University of Michigan 2 MW Ford Nuclear Reactor 1963

Your speaker at the reactor console



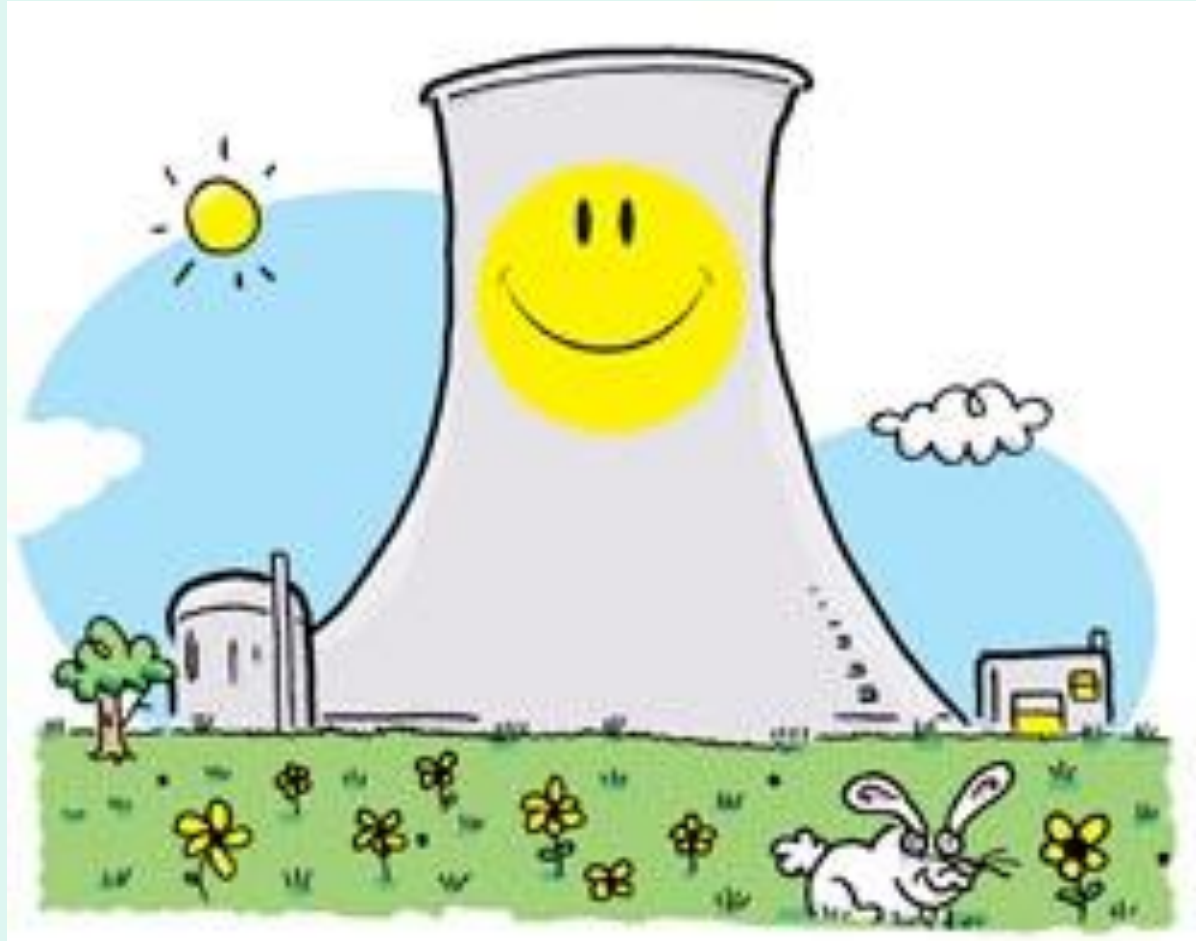
**Nov 11, 1967, Tehran University Research Reactor, First Criticality,
Your lecturer at the control console**



American Nuclear Society, May 2023, 60-year contribution to nuclear industry and ANS membership



QA-Nuclear Happy Face



Yale University Report

- Climate Change in the American Mind – conducted by the Yale Program on Climate Change Communication, Spring 2023
- Those who are “very” or “extremely” sure global warming is happening outnumber those who are “very” or “extremely” sure it is not happening by more than 6 to 1 (53% versus 8%)
- A majority of Americans (61%) understand that global warming is mostly human-caused, by contrast, 28% think it is caused mostly by natural changes in the environment
- A majority of Americans (58%) understand that most scientists think global warming is happening

IEA-OECD 2023

- The world's top 1% of emitters produce over 1000 times more CO₂ than the bottom 1%
- Globally, the top 10% of emitters were responsible for almost half of global energy-related CO₂ emissions in 2021, compared with a mere 0.2% for the bottom 10%
- The top 10% averaged 22 tonnes of CO₂ per capita in 2021, over 200 times more than the average for the bottom 10%. There are 782 million people in the top 10% of emitters, extending well beyond traditional ideas of the super rich
- By comparison, around 0.6% of the world, an estimated 46.8 million individuals are considered millionaires or billionaires

WAPO 9/5/23 CLIMATE-LINKED ILLS THREATEN HUMANITY

Here are the main findings you need to know:

1. Human-induced global warming of 1.1 degrees C has spurred changes to the Earth's climate that are unprecedented in recent human history
2. Pakistan is the epicenter of a global wave of climate health threats, a Post analysis finds
3. The Post analysis showed that by 2030, 500 million people around the world, particularly in places such as South Asia and the Middle East, would be exposed to such extreme heat for at least a month — even if they can get out of the sun. The largest population, 270 million was in India, followed by 190 million in Pakistan, 34 million across the Arabian Peninsula and more than 1 million apiece in Mexico and Sudan