

A large, central image depicts a tree with a starkly split canopy. The left side of the tree is filled with dense, dark green foliage, while the right side is composed of bare, thin, and spindly branches. The tree stands on a ground that is also split: the left half is a lush, green field, and the right half is a parched, cracked, and greyish-brown expanse. The sky above is filled with white, fluffy clouds, and several small, dark birds are seen in flight across the upper portion of the frame.

# Climate Change in Pakistan

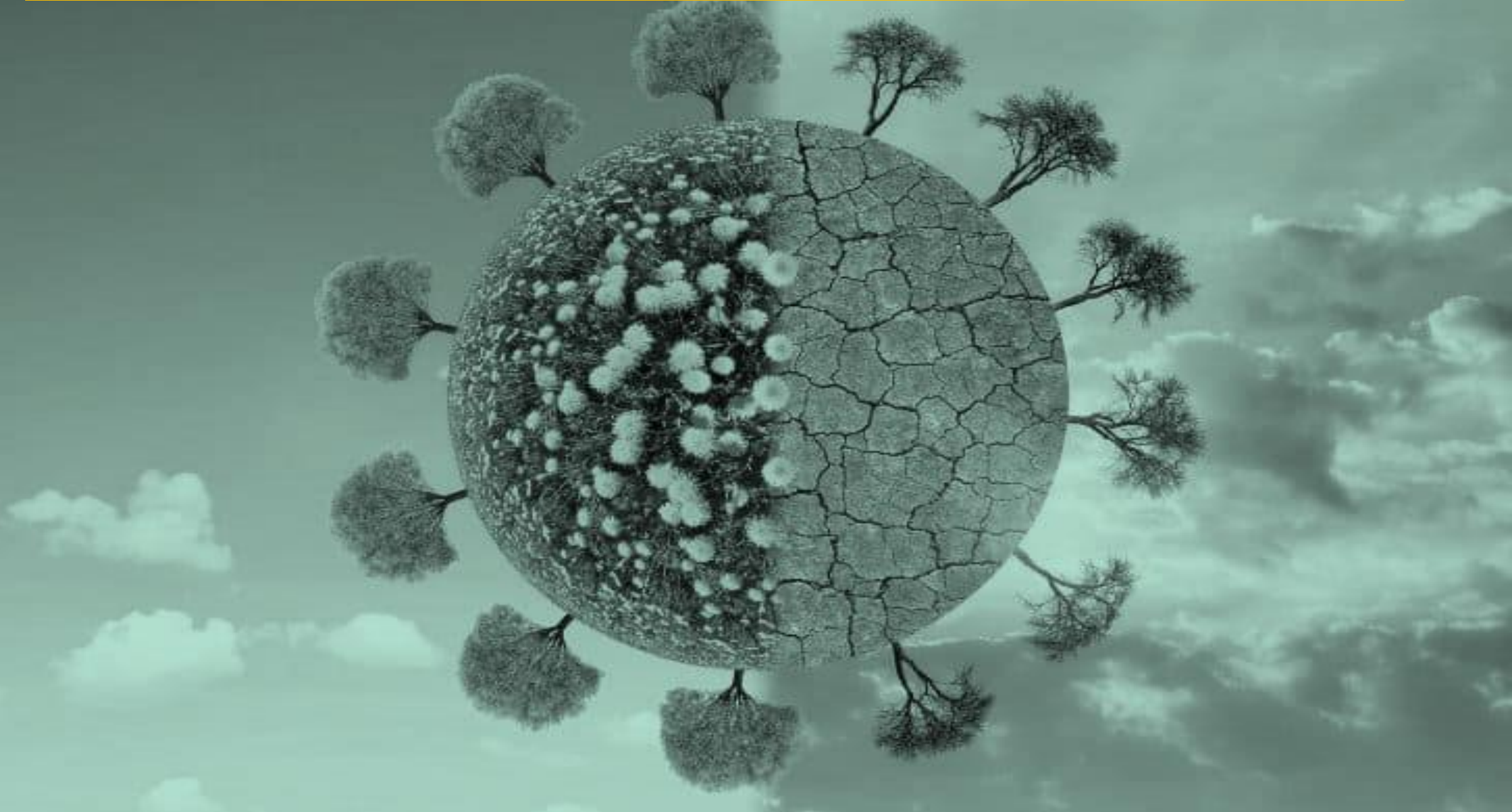
*November 2022*

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# Global climate change and its urgency



# Global Climate Change

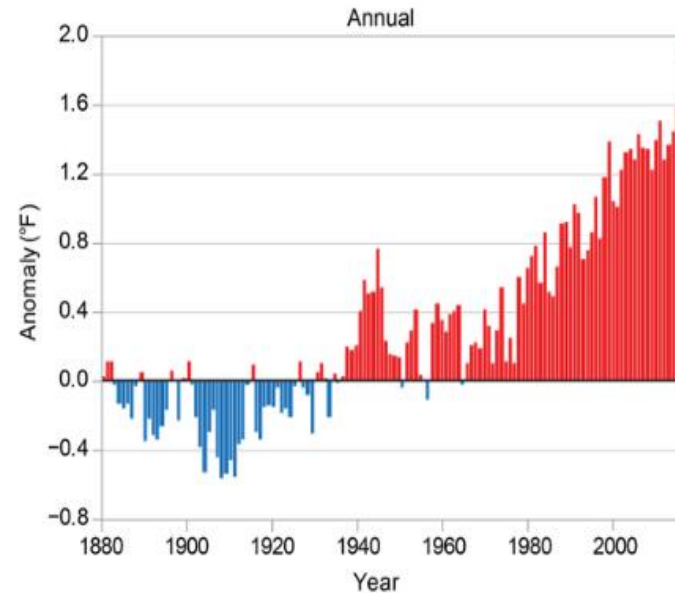
Though warming has not been uniform across the planet, the upward trend in the globally averaged temperature shows that more areas are warming than cooling

## Historical trend of climate change

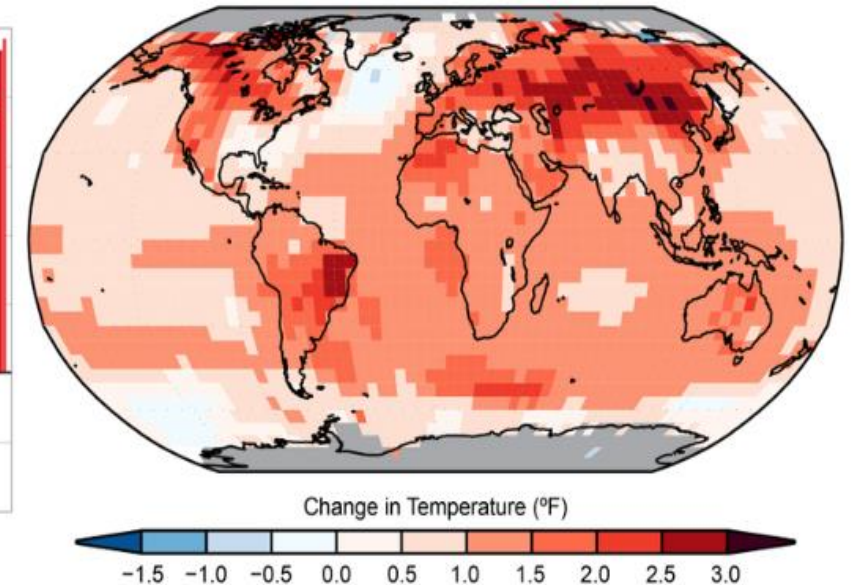
- Global annual average temperature (as calculated from instrumental records over both land and oceans) has increased by more than 1.2°F (0.65°C) for the period 1986–2016 relative to 1901–1960; the linear regression change over the entire period from 1901–2016 is 1.8°F (1.0°C).
- Many lines of evidence demonstrate that it is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.
- Global climate is projected to continue to change over this century and beyond. The magnitude of climate change beyond the next few decades will depend primarily on the amount of greenhouse (heat-trapping) gases emitted globally and on the remaining uncertainty in the sensitivity of Earth's climate to those emissions

## As per US Global Change Research Program

Global Land and Ocean Temperature Anomalies



Surface Temperature Change



Global annual average temperature has increased by more than 1.2°F (0.7°C) for the period 1986–2016 relative to 1901–1960. Red bars show temperatures that were above the 1901–1960 average, and blue bars indicate temperatures below the average.

# Significant Climate Anomalies and Events in 2021



## GLOBAL AVERAGE TEMPERATURE

The January-December 2021 average global surface temperature was the sixth highest since global records began in 1880.

## ARCTIC SEA ICE EXTENT

During its growth season, the Arctic had its seventh-smallest annual maximum extent (tied with 2007) on record. During its melt season, the Arctic had its 12th-smallest annual minimum extent on record.

## NORTHWESTERN U.S. AND WESTERN CANADA

An extreme heat wave affected much of the northwestern U.S. and western Canada during the last week of June. Canada set a new national maximum temperature.

## NORTH AMERICA

North America had its seventh-warmest year on record.

## HURRICANE IDA

Ida was a dangerous Category 4 hurricane when it made landfall in the U.S. state of Louisiana on August 29 – the same day that Hurricane Katrina did 16 years earlier. Ida caused significant damage to parts of Cuba and the southern and northeastern U.S.

## EASTERN NORTH PACIFIC HURRICANE SEASON

Above-average activity: 19 storms, including 8 hurricanes.

## HURRICANE GRACE

Grace was one of the strongest hurricanes to make landfall in eastern Mexico.

## SOUTH AMERICA

The year 2021 was South America's sixth-warmest year on record.

## ATLANTIC HURRICANE SEASON

Above-average activity: 21 storms, including 7 hurricanes. This was the third highest number of named storms on record.

## AFRICA

The year 2021 tied with 2019 as Africa's third-warmest on record.

## GLOBAL CYCLONE ACTIVITY

94 storms, including 37 hurricanes/cyclones/typhoons. The number of global hurricane-strength storms was the lowest in the 41-year record.

## ANTARCTIC SEA ICE EXTENT

During its growth season, the Antarctic reached a maximum extent that was near-average. During its melt season, the Antarctic had its 12th smallest minimum extent on record.

## EUROPE

Europe's 2021 temperature was the ninth-highest on record.

## SOUTHERN EUROPE

An intense heat wave impacted parts of southern Europe. Sicily had a daily maximum temperature that if verified, would be Europe's highest maximum temperature on record.

## ASIA

Asia had its seventh-warmest year on record.

## TYPHOON SURIGAE

Surigae was an extreme cyclone, with the strongest maximum wind speed ever recorded for a storm during the months of January-April anywhere in the world.

## TROPICAL CYCLONE TAUUKTAE

Tauktae was one of the strongest cyclones on record to make landfall on India's west coast.

## NORTH INDIAN OCEAN CYCLONE SEASON

Near-average activity: 5 storms, including 3 cyclones.

## SOUTH INDIAN OCEAN CYCLONE SEASON

Near-average activity: 12 storms, including 5 cyclones

## CYCLONE SEROJA

Cyclone Seroja brought strong winds and record rainfall to parts of Western Australia. Seroja also affected Indonesia, causing historic floods and landslides.

## WESTERN NORTH PACIFIC TYPHOON SEASON

Below-average activity: 23 storms, including 10 typhoons.

## TYPHOON RAI

Rai was a strong and destructive typhoon. It made landfall in the southern Philippines on December 16, wreaking havoc across the region.

## OCEANIA

Although Oceania had an above-average temperature, it was its coldest year since 2012.

## SOUTHWEST PACIFIC CYCLONE SEASON

Near-average activity: 9 storms, including 4 cyclones

Please note: Material provided in this map was compiled from NOAA's State of the Climate Reports. For more information please visit: <http://www.ncdc.noaa.gov/sotc>

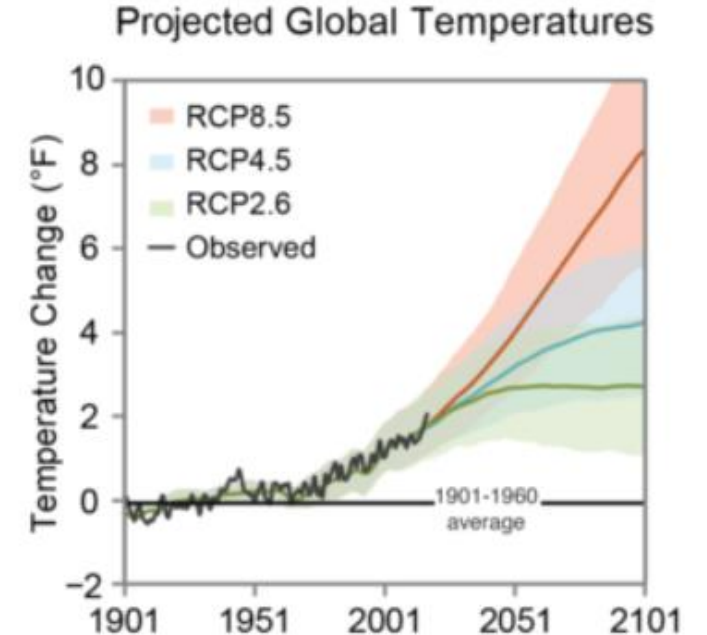
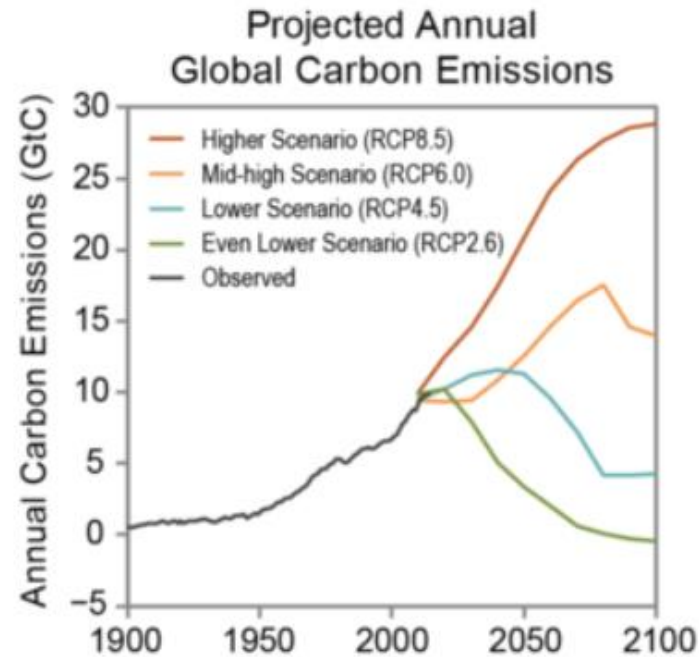


## Past and present-day greenhouse gas emissions will affect climate far into the future

### Future projections of climate change

- Many greenhouse gases stay in the atmosphere for long periods of time. As a result, even if emissions stopped increasing, atmospheric greenhouse gas concentrations would continue to increase and remain elevated for hundreds of years.
- Moreover, if we stabilized concentrations and the composition of today's atmosphere remained steady (which would require a dramatic reduction in current greenhouse gas emissions), surface air temperatures would continue to warm. This is because the oceans, which store heat, take many decades to fully respond to higher greenhouse gas concentrations.
- The ocean's response to higher greenhouse gas concentrations and higher temperatures will continue to impact climate over the next several decades to hundreds of years.

### Projections on Global Carbon Emissions and Temperatures



# Climate Change in Pakistan: An Overview



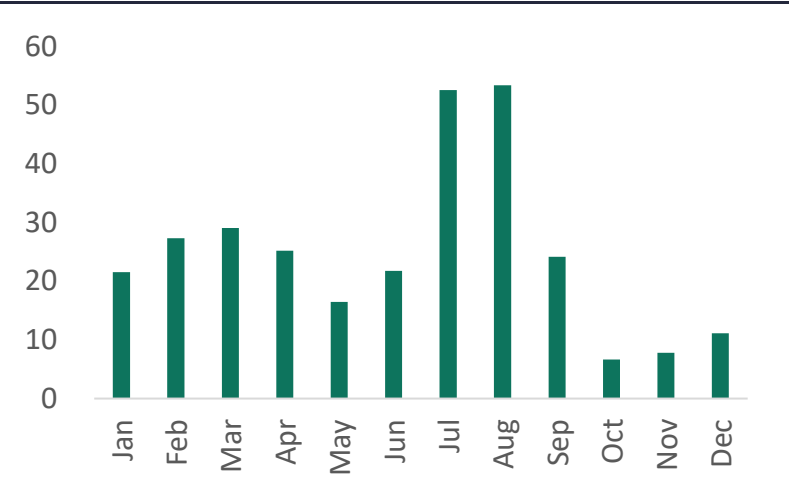
# Overview of Pakistan's Climate



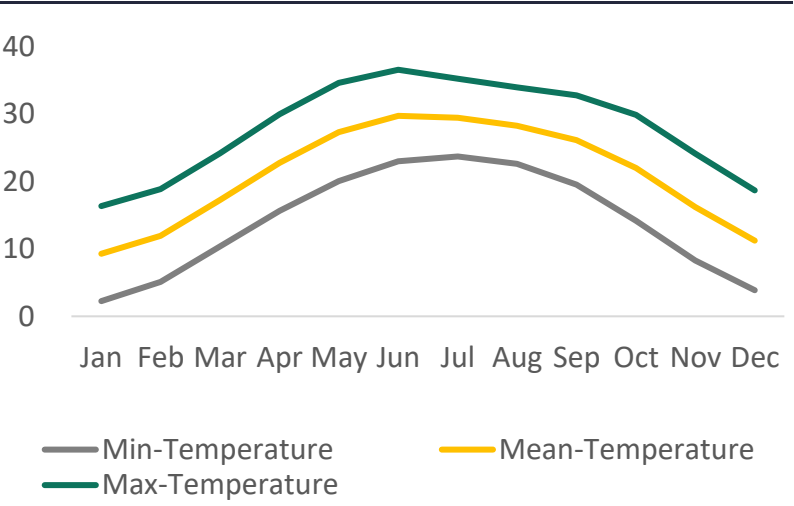
## Upward Trend for Pakistan's Temperature

- Pakistan experiences a spell of high temperature starting from April to September
- The months for high rainfall are in the monsoon season which lasts from June to August
- The historic distribution of the annual mean temperature of Pakistan shows that over the past 7 decades (1951-2020), there has been an increasing trend in the average mean temperature
- However, in the recent 3 decades (1991-2020), the increase has been significantly high. Moreover, the distribution curve has also become flatter, which indicates that there is more variability in the temperature and hence a higher chance for extreme temperature
- The Projected mean temperature is shown along different Shared Socioeconomic Pathways (SSP) with SSP 1-1.9 representing a very low greenhouse gas emission and SSP 5-8.5 representing a very high greenhouse gas emission

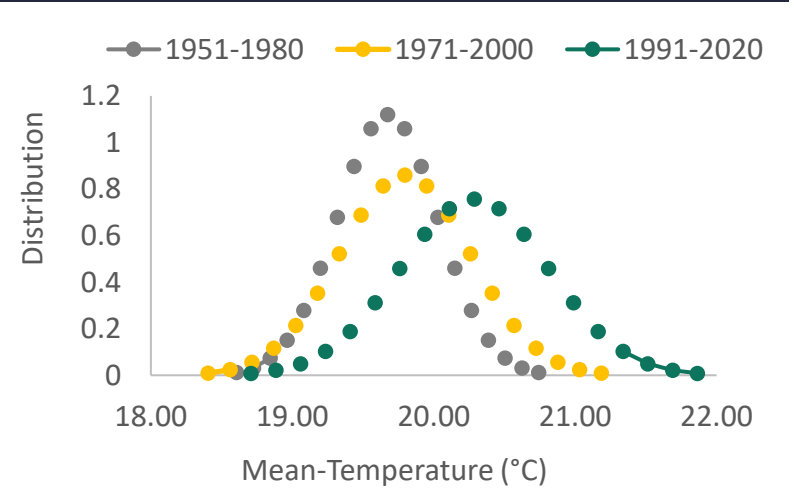
## Average Precipitation (MM) 1990-2020



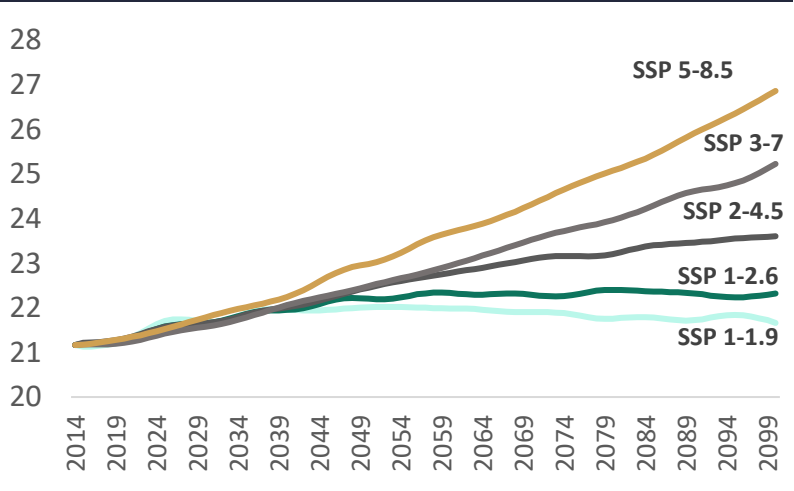
## Mean Temperature (°C) 1990-2020



## Annual Mean Temperature Distribution



## Projected Mean Temperature

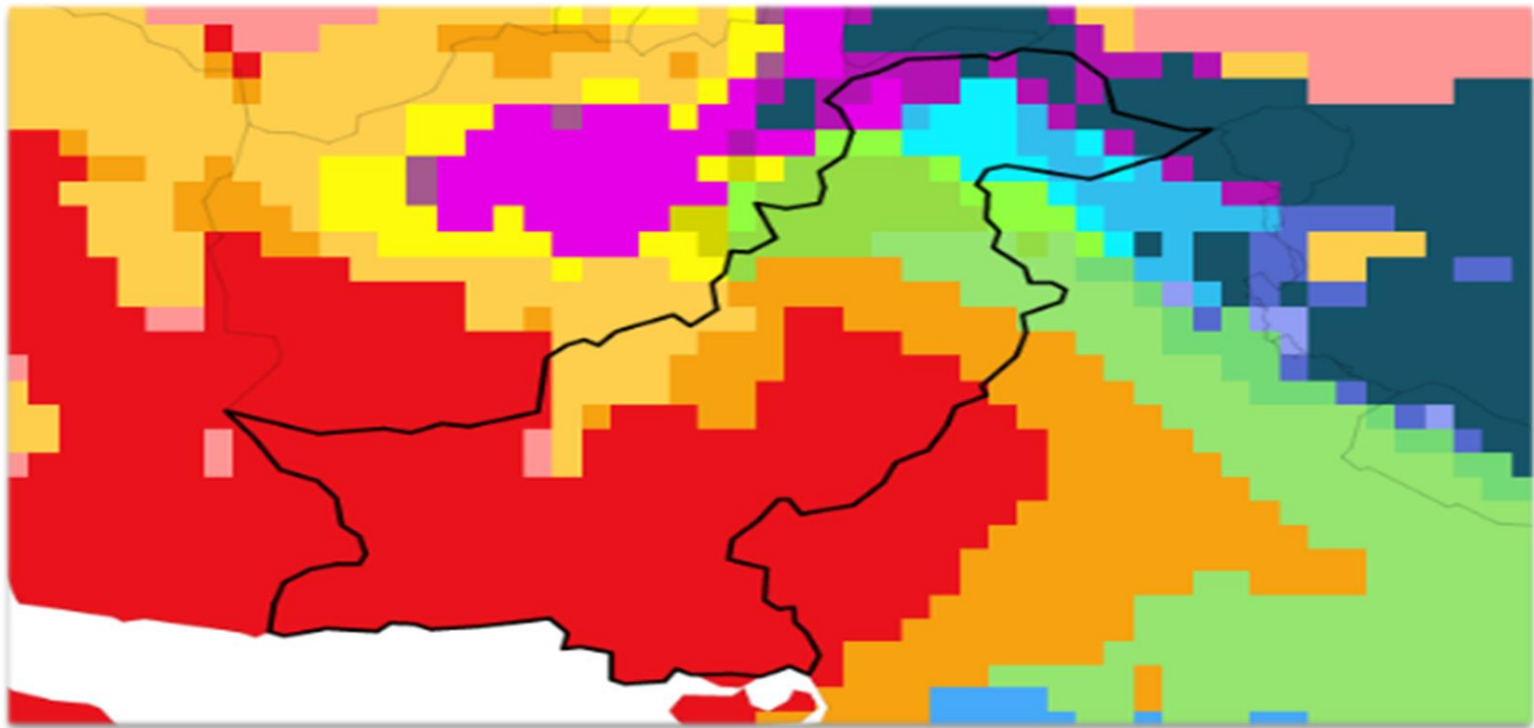
















## Geographic Classification of Pakistan Climate

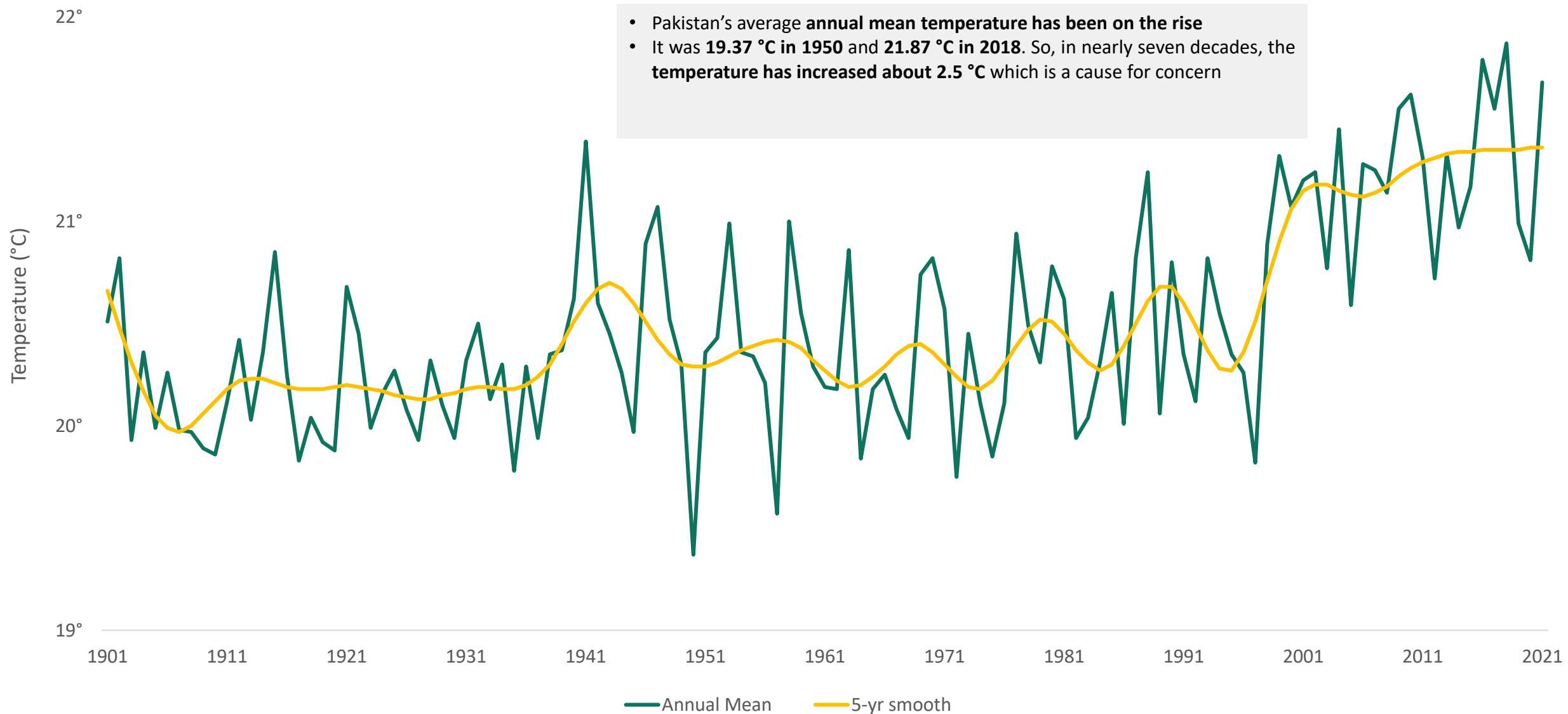
- Pakistan is characterized by diverse topography, ecosystems, and climate zones
- The global surface temperature keeps rising, despite natural variability
- The **Köppen-Geiger Climate Classification** shows the evolution of the historical record for Pakistan
- The climate of the country in its lower southern half is arid and hyper-arid as the climate near the coast and along the lowland plains of the Indus River is generally dry and hot
- Majority of Pakistan’s population lives along the Indus River so most of them experience hot temperature
- Whereas the northern half of the country lies between semi-arid to very humid, the climate becomes gradually cooler as we move up towards the northern uplands and the Himalayas

## As per Köppen-Geiger Climate Classification (1991-2020)



	Hot Desert Climate		Monsoon-influenced Subpolar Oceanic Climate		Monsoon-influenced Hot Summer Humid Continental Climate
	Cold Desert Climate		Monsoon-influenced Temperate Oceanic Climate		Mediterranean-influenced Hot-summer Humid Continental Climate
	Hot-Semi Arid Climate		Monsoon-influenced Humid Tropical Climate		Mediterranean-influenced Warm-summer Humid Continental Climate
	Cold-Semi Arid Climate		Monsoon-influenced Warm Summer Humid Continental Climate		Extremely Cold Subarctic Climate

# Observed Average Annual Mean-Temperature of Pakistan from 1901-2021





# Climate Changes Impacts on Natural Resources & Economic Sectors



In short term, Climate Change is more likely to cause an adverse impact on water quality rather than the total volume of water flow that could impact the demand for water

- Water demand is driven by three sectors: **agriculture, municipal, and industrial**
- Over the past 5 decades, there has been a significant increase in the demand for water and the highest increase in absolute terms has been from the agriculture sector
- Based on a Report Published by UNDP Pakistan in 2017, in the short term (prior to the 2050s) the climate change factors are expected to have little impact on the total volume of the water flow coming in from the Indus River Basin
- Instead, climate change is more likely to change the timing of the peak flow and increase the variability of flow volume in the Indus River, primarily due to less predictable precipitation (monsoon) patterns rather than changes in the overall flow volume from glacial and nival (snow melt) sources
- However, climate change can lead to an adverse impact on the water quality and the presence of water-borne diseases in the following ways:
  - Water quality parameters, including acidity levels, oxygen, and nutrient levels, are particularly sensitive to increasing water temperatures, which influences the blooms of various planktonic species that are directly or indirectly hazardous to human health<sup>1</sup>
  - Climate change may lead to changes in monsoon rainfall patterns and other variations in precipitation levels that could lead to greater frequency of heavy rainfall events and more extreme events like floods and droughts that have a direct impact on water quality and water-borne and water-related diseases<sup>1</sup>

Water Demand Sector Wise

Year	Agriculture	Industry	Municipal
1975	150.3	1.5	1.5
1991	150.6	2.5	2.5
2000	162.7	3.4	6.4
2008	172.4	1.4	9.6

Source: [UNDP Pakistan](#)

<sup>1</sup> UNDP, The vulnerability of Pakistan’s water sector to the impacts of climate change (2017) URL: <https://www.iisd.org/publications/report/vulnerability-pakistans-water-sector-impacts-climate-change-identification-gaps> 12

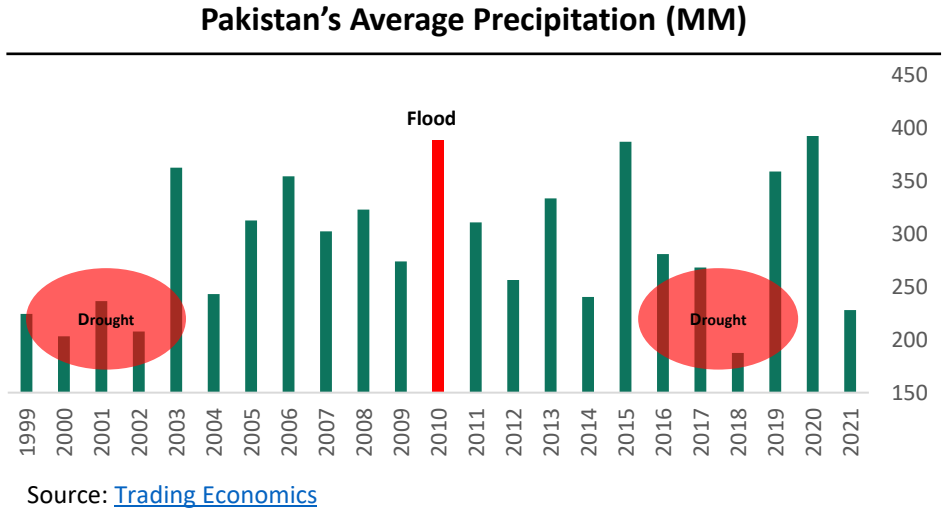


# Climate Changes Impact on Agriculture Sector



Agriculture Sector is the backbone of Pakistan’s economy, it contributes to around ~23% of the GDP, and provides employment to around 37.4% of the labor force

- Pakistan’s crops are highly sensitive to changes in temperature and water availability. Temperature rises in Pakistan’s agricultural region of 0.5°C–2°C could lead to around an 8%–10%<sup>1</sup> loss in yield
- Climate changes causing extreme climate events such as Floods & Droughts have the potential to cause significant economic adverse impacts to Pakistan’s agriculture sector
- Pakistan’s mountain region’s vulnerability to glacial melt, increasing temperature along with extreme changes in precipitation increases Pakistan’s exposure to flood and drought
- According to Food and Agriculture Organization, the 2010 flood affected the lives of over 18 Million<sup>2</sup> people and around 80%<sup>2</sup> of the affected population was dependent on the agricultural sector
- The standing crops (maize, rice, vegetables, sugarcane, fodder, and cotton fields) damaged by the flood were reported to be around 2.4 Million (Ha)<sup>2</sup>, and more than 1.2 million<sup>2</sup> livestock (excluding poultry) died due to the flood. Similarly, a recent flood in Aug 2022, has impacted 2 Million Acre of Crops and ~800k livestock
- Pakistan is exposed to meteorological drought which is usually associated with a precipitation deficit and Pakistan faces an annual median probability of severe meteorological drought of around 3%<sup>3</sup>
- The extended drought period between 2015–2017 had also affected the agriculture sector as it led to a drastic reduction in crop harvest of up to 53%<sup>4</sup> and a reduction in livestock output by 48%<sup>4</sup> in the worst affected districts



Impact on Agriculture from Floods and Drought		
Event	Impact on Crops	Impact on Livestock
1999-2000 Drought	2.57 Million Tons <sup>5</sup>	~23.5 Million Livestock affected <sup>5</sup>
2010 Flood	2.4 Million (ha)	~1.2 Million Livestock
2015-2017 Drought	53% Reduction in Crop Harvest	48% Reduction in Livestock Output
2022 Flood	2 Million Acre	~800,000 Livestock

Source: [OCHA](#), [FAO](#), and [CSCR](#)

<sup>1</sup> Dehlavi, A., Gorst, A., Groom, B., Zaman, F. (2015) URL: [https://d2ouvy59p0dg6k.cloudfront.net/downloads/110215\\_idrcstudy\\_1.pdf](https://d2ouvy59p0dg6k.cloudfront.net/downloads/110215_idrcstudy_1.pdf)  
<sup>2</sup> FAO. Pakistan Flooding. (2011) URL: <https://www.fao.org/resilience/resources/resources-detail/en/c/173481/>  
<sup>3</sup> WBG Climate Change Knowledge Portal (CCKP, 2021). Climate Projections. URL: <https://climateknowledgeportal.worldbank.org/country/pakistan/climate-data-projections>  
<sup>4</sup> Durrani, Center for Strategic and contemporary research (2018). URL <https://cscr.pk/explore/themes/energy-environment/lessons-pakistan-droughts-past/>  
<sup>5</sup> OCHA, Drough – Pakistan (2001). URL: <https://reliefweb.int/report/pakistan/drought-pakistan-update-no-12>

Electricity consumption in Pakistan is highly related to the prevailing temperature. A higher temperature tends to lead to high electricity demand

- The table shows a comparison between the monthly temperature trend and the monthly consumption of electricity demand
- Based on this information, it is evident that in high-temperature months there is a significantly high demand for electricity
- Research suggests that on average a one-degree increase in ambient temperature can result in a 0.5%–8.5%<sup>1</sup> increase in electricity demand
- The rationale for this increased electricity demand is the demand-driven by increased demand for air cooling purposes by residential units and business units
- As per a recent World Bank report, Pakistan faces an increase in average temperatures which is significantly above the global average. The report projected an average increase of 1.4°C-2.6°C<sup>2</sup> in daily maximum temperature during the period between 2040 and 2059 and this could go up to 5.3°C<sup>2</sup> during the 2080-99 period under various scenarios
- Based on this, we can conclude that there will be an increase in the energy demand due to increasing temperature caused by climate changes since higher temperature leads to higher consumption of electricity for cooling purposes

High-Temperature Impact Grid Load

Month	System Peak Load Demand (MW) 2020-2021	Average Temperature for Pakistan (°C) 1990-2020
January	17,012	9.31
February	16,433	11.96
March	17,617	17.26
April	21,322	22.77
May	23,847	27.31
June	26,682	29.73
July	26,085	29.44
August	26,781	28.25
September	23,931	26.12
October	20,857	22.01
November	15,962	16.2
December	17,177	11.25

Source: [NEPRA](#), and [World Bank](#)

<sup>1</sup>Santamouris, M., Cartalis, C., Synnefa, A., & Kolokotsa, D. (2015). URL: <https://www.sciencedirect.com/science/article/abs/pii/S0378778814007907>

<sup>2</sup> World Bank, Climate Risk Country Profile (2021) URL: [https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15078-WB\\_Pakistan%20Country%20Profile-WEB.pdf](https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15078-WB_Pakistan%20Country%20Profile-WEB.pdf)



# Challenges Faced by Climate Change



Pakistan faces the risk of increasing temperature that could lead to issues such as heat waves, glacial melt leading to flooding, and uncertainty in precipitation leading up to droughts in some areas of the country

As per World Bank, Pakistan faces rates of warming considerably above the global average with a potential rise of 1.3°C–4.9°C by the 2090s over the 1986–2005 baseline<sup>1</sup>

**Floods**

Pakistan has 7,253 known glaciers, which exposes Pakistan to a high risk of glacial melt given that most of Pakistan’s population lives along the Indus river. As per UN Development Programme<sup>2</sup>, “the glaciers in Pakistan's Gilgit-Baltistan and Khyber Pakhtunkhwa regions are melting rapidly, creating more than 3,000 lakes. Around 33 of these are at risk of sudden bursting, which could unleash millions of cubic meters of water and debris putting 7 million people at risk”

**Heatwaves**

The annual highest record temperature in many regions of the country is above 38°C, hence this exposes the majority of the population to heatwaves that could eventually lead up to health-related issues for many. Karachi and Lahore, the two large urban cities of Pakistan have been identified as being the most vulnerable to an increase in extreme heat and high mortality risk associated with the heatwave. As per an estimate, there were 126 heatwaves recorded during the period 1997-2015 in Pakistan with 7 being the average number of heatwaves per year. Moreover, a recent Met Office Study<sup>3</sup> suggests that Pakistan is 100 times more likely to experience record-breaking heatwaves in 2022

**Droughts**

Unpredictability in precipitation and Pakistan’s dependence on precipitation for ensuring the supply of water to some of the drastically dry regions leads to a potential threat of drought. In the first quarter of 2022, the overall rainfall in Pakistan was about ~21.6% below the normal average, and this low rainfall affected Sindh, Balochistan, South Khyber Pakhtunkhwa, and Southern Punjab (Cholistan Region). Severe drought-like conditions had emerged in Chagi district whereas, moderate conditions had emerged over the Kharan, Nushki, and Washuk districts of Balochistan

Daytime Max Temperature

Region	Annual Average
Balochistan	31.9
Sindh	34.4
KP	28.9
Punjab	31.0
GB/Kashmir	29.5

Source: [World Data](#)

Area Weighted Rainfall Departure (%) Compared to Normal Conditions

Region	(January to April) 2022
Balochistan	-17.0%
Sindh	69.4%
KP	-39.6%
Punjab	-16.3%
GB/Kashmir	-25.0%
Pakistan	-21.6%

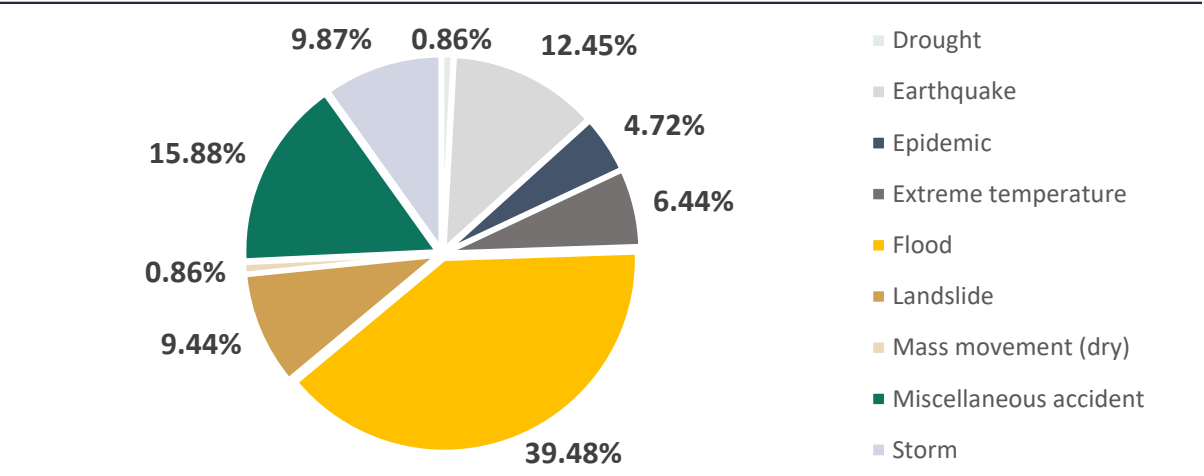
Source: [Pakistan Meteorological Department](#)

<sup>1</sup> World Bank, Climate Risk Country Profile (2021) URL: [https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15078-WB\\_Pakistan%20Country%20Profile-WEB.pdf](https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15078-WB_Pakistan%20Country%20Profile-WEB.pdf)  
<sup>2</sup> BBC, How Pakistan floods are linked to climate change (2022) URL: <https://www.bbc.com/news/science-environment-62758811>  
<sup>3</sup> Met Office, Climate change making heatwaves more intense (2022) URL: <https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2022/southern-asian-heatwave-attribution-study-2022>

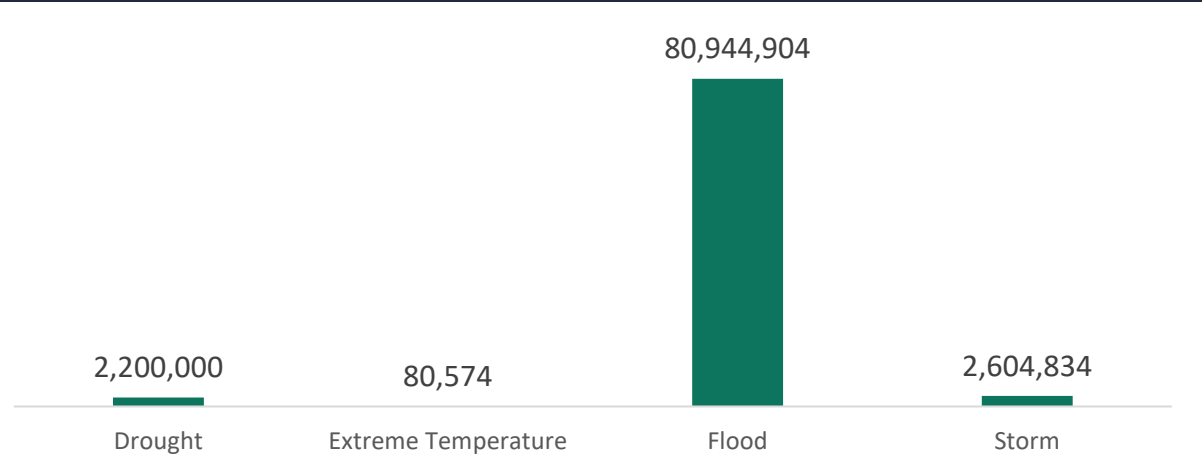
# Climate Changes Related Natural Hazards in Pakistan

Floods have been the highest contributor in terms of damages among the natural hazards caused by the climate changes for the period 1900 to 2020

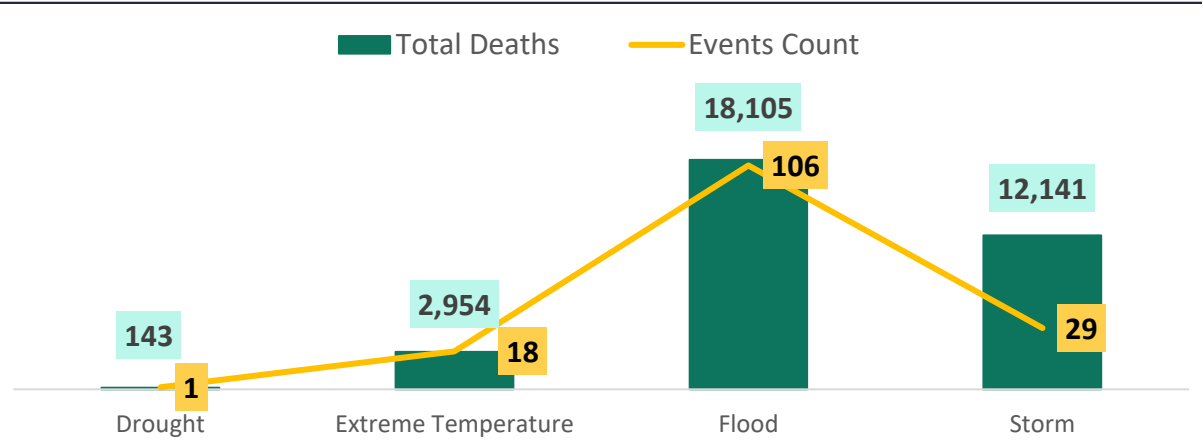
Average Annual Natural Hazard Occurrence for 1980-2020



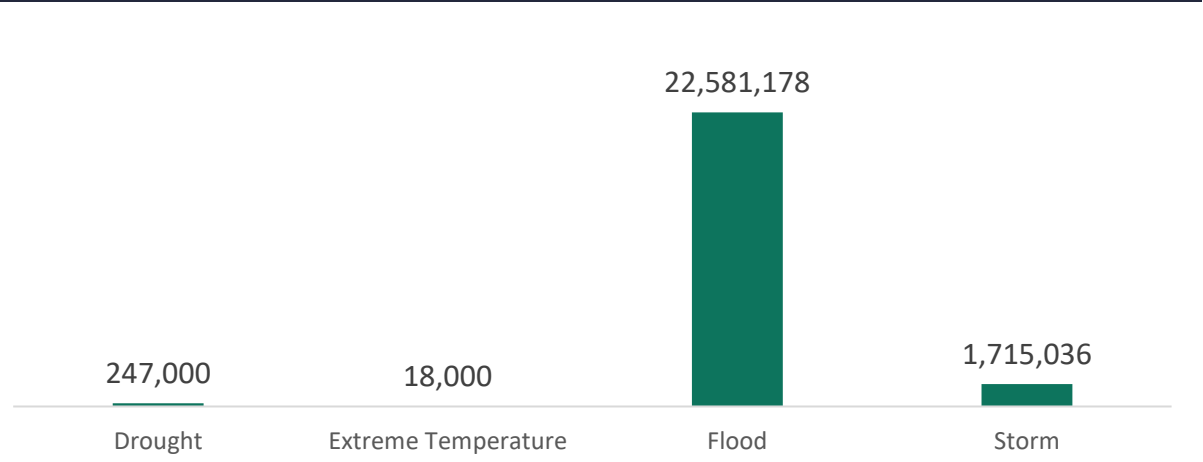
Total Number of Affected People



Total Events & Deaths Caused by Natural Hazards (1900 to 2020)



Total Damage (USD 000)



Source: [Climate Change Knowledge Portal](#)



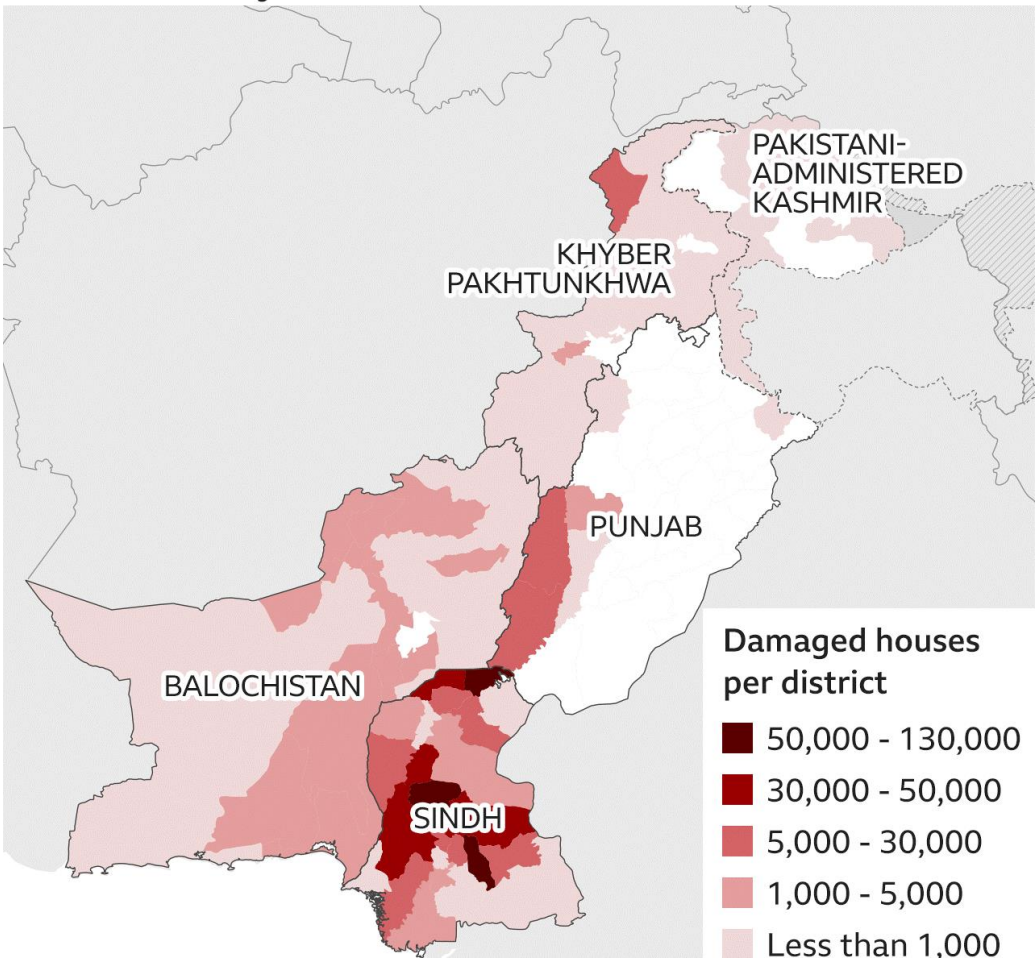
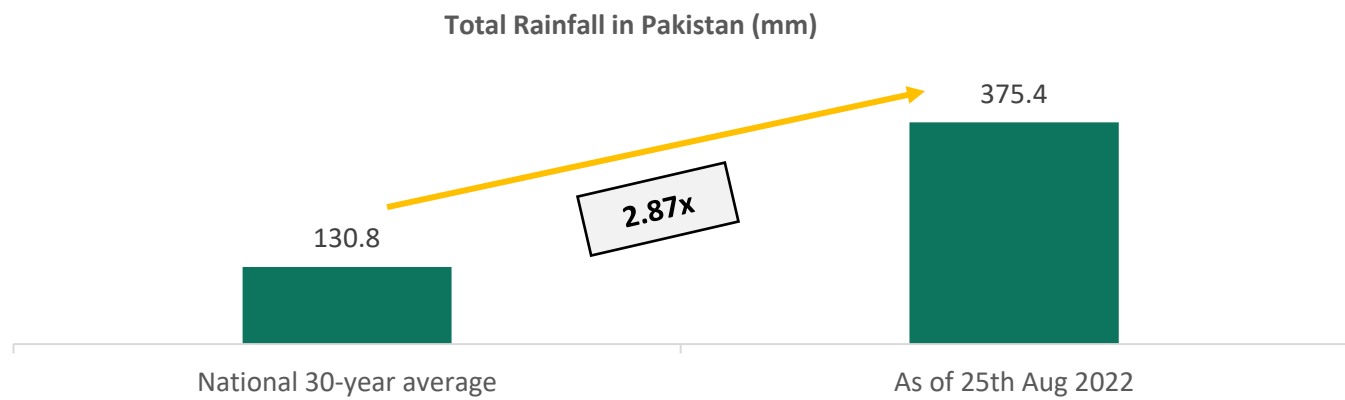
## Recent Floods in Pakistan



# 2022 Monsoon Floods in Pakistan

1,391K	897K	2M	1,731	12,867	1,164K
Houses destroyed	Houses damaged	Acres of crops impacted	Deaths	Injured	Livestock lost

- 116 districts have been affected in the recent floods with 85 districts officially declared ‘calamity hit’
- At least 1,731 people have been killed and 12,867 people have been injured
- Rainfall nationwide this monsoon was 2.87 times higher than the national 30-year average
- Some provinces have received more than five times as much rainfall as their 30-year average
- The Government of Pakistan has allocated PKR 35 billion (US\$ 173 million) to aid flood-affected people
- The humanitarian situation is expected to deteriorate as heavy rains will continue to cause flooding and landslides resulting in displacement & damage across the country



Source: [OCHA](#); [NDMA](#) (figure extracted on Oct. 27)



# Developed World's Role in Reducing Global Warming





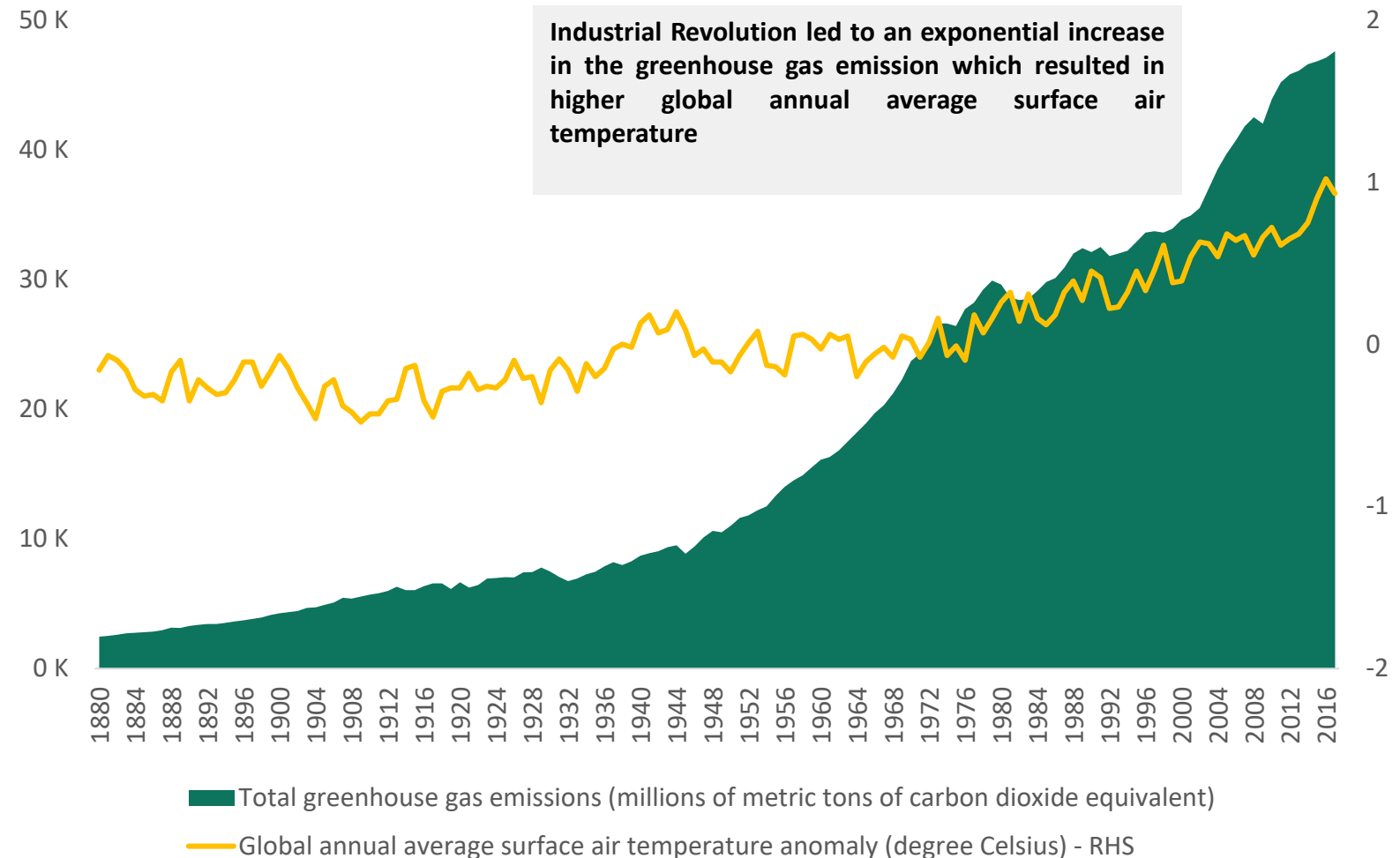
# In 2016, Countries From Around the Globe Committed to Reduce GHG Emission

In 2016, 195 governments entered into the Paris Agreement with the goal of limiting global warming to pre-industrial levels.

## The Paris Agreement

- **Industrial Revolution** marks the time when human activities began releasing greenhouse gases into the atmosphere in massive quantities
- Since then, global temperatures have risen rapidly, and NASA estimates that the rate of global warming over the next century will be **20 times** faster than historical averages, which is a cause for serious concern
- To address this concern, 195 governments agreed to the text of the most significant global climate agreement in history on 12<sup>th</sup> December 2015 in Paris known as **the Paris Agreement**
- The international agreement commits nearly every country in the world to lowering greenhouse gas emissions to curb the dangerous effects of climate change
- The Paris Agreement, which entered into force on 4<sup>th</sup> November 2016 aims to prevent global temperatures from rising above pre-Industrial Revolution temperatures

## Greenhouse Gas Emissions and Temperature Change



# Renewable Energy Key to Emission Reduction

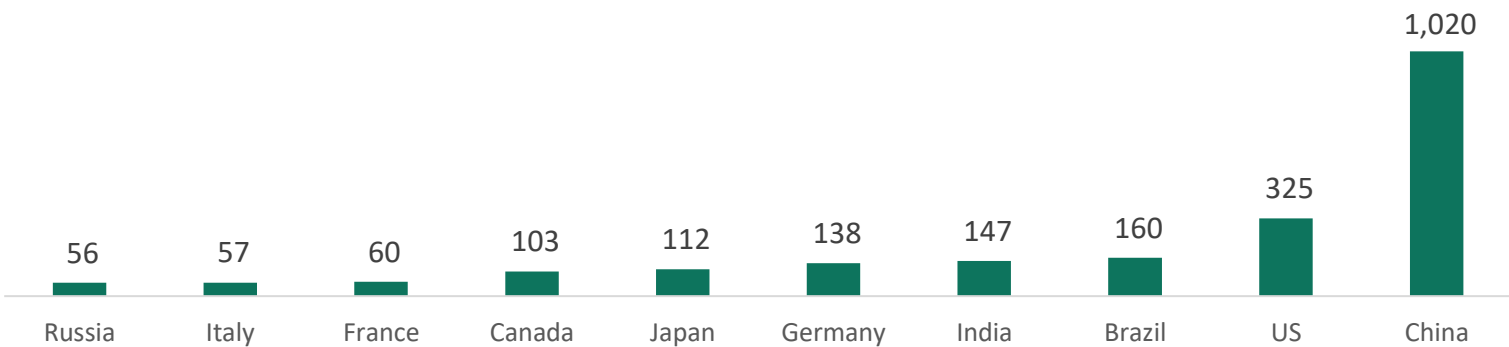
It is not possible to achieve Paris Agreement targets and lower GHG emission without focusing on renewable energy sources.

## Energy accounts for ~ 70% of global GHG emissions

- As per United Nations, Energy connects in one way or another to some 70 per cent of global emissions, and a shift to low carbon energy forms is critical. It is impossible to keep the Paris Agreement temperature goals alive without a rapid energy transition
- As per International Renewable Energy Agency, a third of global power capacity in 2018 was based on renewable energy
- Renewable Energy has been growing in other GHG-emitting countries such as the US, however, fossil fuel still dominates the energy supply in the country
- Countries such as the US and other Europeans countries which have high GHG emission levels from the energy sector need to consider to follow the footsteps of China to achieve their targets for the lowering GHG emission

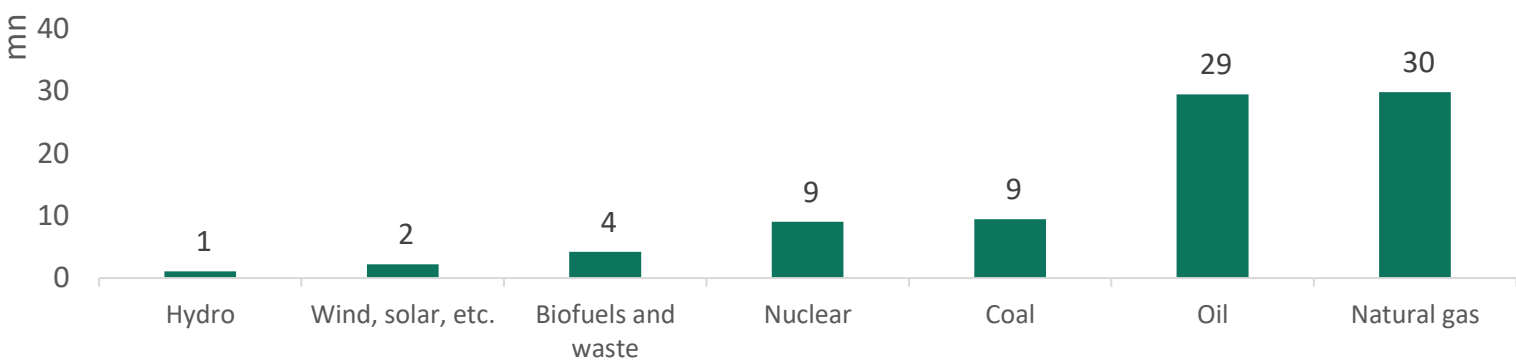
Source: [IRENA](#), [UN](#)

Energy Capacity in Gigawatts (Top 10 Countries in 2021)



Source: [Statista](#),

Total Energy Supply by Source in 2021 (United States)



Source: [IEA](#)

# GHG Emissions from the Energy Sector by Developed Countries

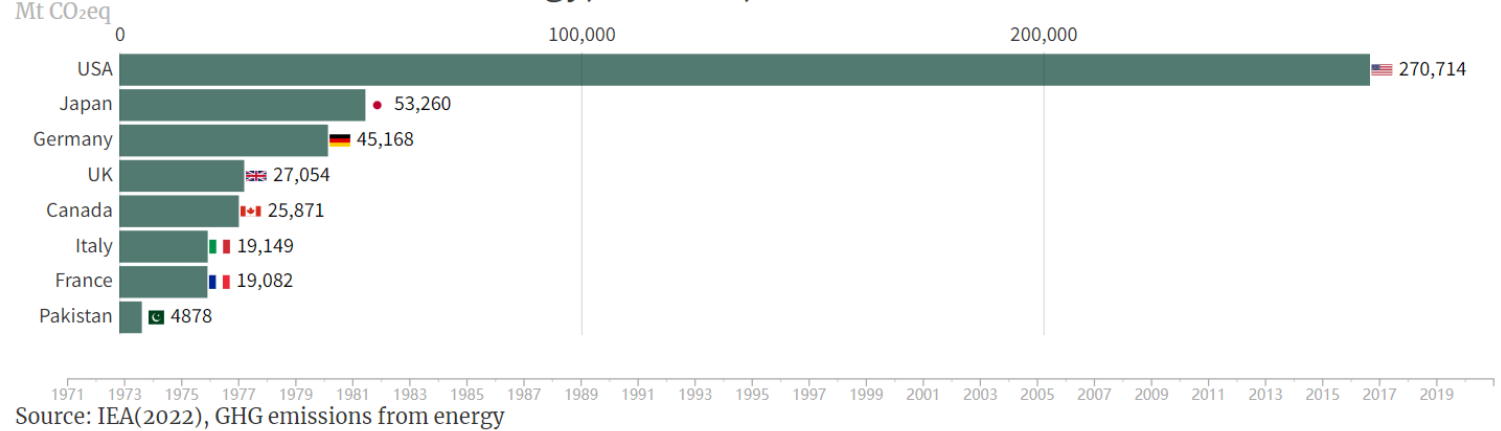
The emerging world should not face undue pressure from developed nations to take drastic steps in reducing greenhouse emissions.

## Developed countries emit far more GHG per capita than emerging countries

- Cumulative GHG emissions originating from the developed world have significantly outpaced emerging countries. As per IEA, from 1971 to 2020 in the energy sector (same below), G7 accounted for 34.5% of the world's total GHG emissions. **The US alone takes up 20% of the world's cumulative emissions, nearly 56x higher than Pakistan.**
- Carbon emissions per capita from the developed world have also outpaced emerging nations by significant margins. As per IEA, per capita CO<sub>2</sub> emissions from OECD countries were 2.35x those from non-OECD countries in 2020. Per capita CO<sub>2</sub> emissions from G7 countries outpaced non-OECD countries by 2.9x and Pakistan by nearly 13x. This figure was significantly higher prior to the 2000s.
- The US is the world's leading GHG emitter. In 2020, per capita CO<sub>2</sub> emissions in the US reached 12.9 tons, 3x world average of 4.08 tons and 17x that of Pakistan.

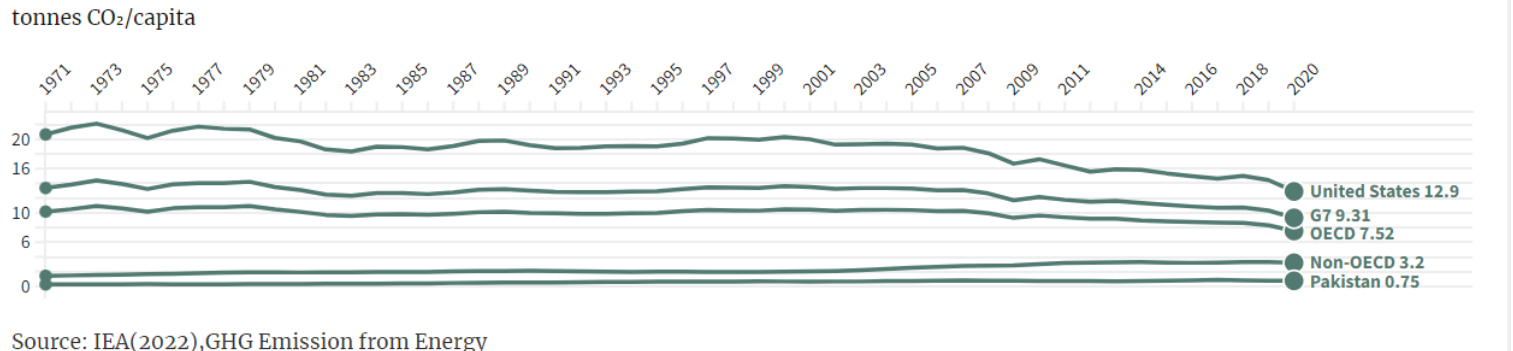
## Total cumulative emissions from US nearly 56x those from Pakistan

### Total GHG emissions from energy, Pakistan, G7



## Per capita CO<sub>2</sub> emissions by G7 countries outpaced Pakistan by nearly 13x

### CO<sub>2</sub> emissions/population





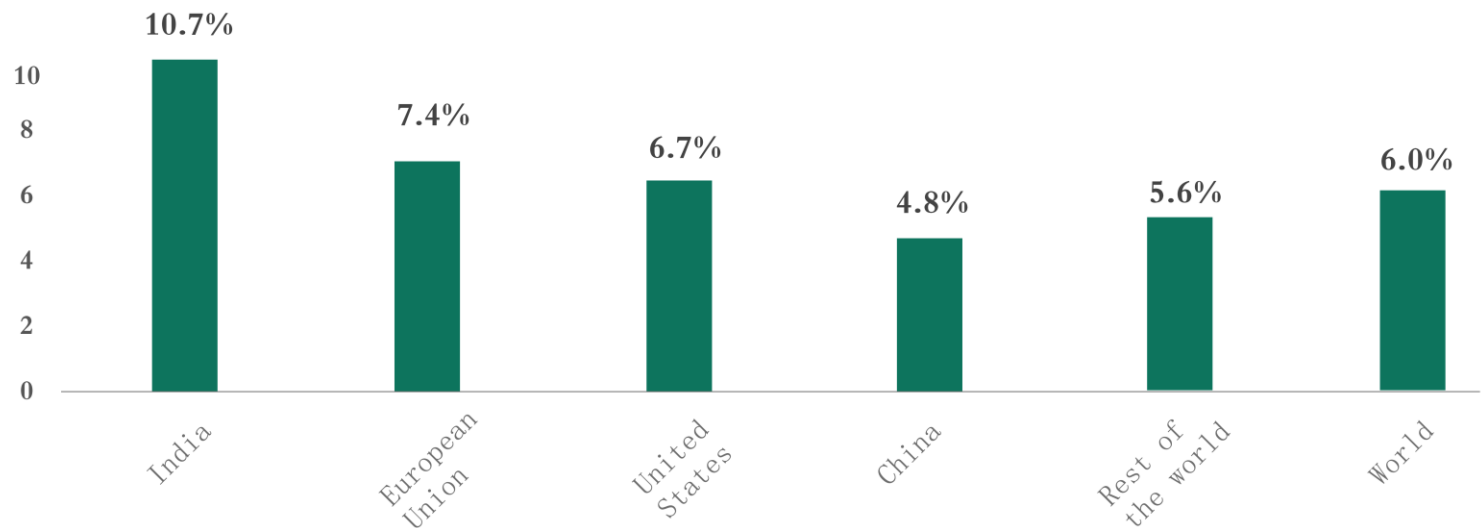
# However, Post-Covid Rebound Led to an All-Time High CO<sub>2</sub> Emission Level

Despite the Paris Agreement, Post Covid increase in electricity demand led to the highest ever level of emissions from power plants and coal consumption, which pushed the CO<sub>2</sub> emission level to an all-time high.

## Post-Covid Boom led to High Emission

- As per United Nations, the rebound in economic activity after covid led to a 4 percent increase in the global energy demand, which was mainly met by fossil fuels
- Post-Covid, global CO<sub>2</sub> emissions from energy combustion and industrial processes reached all-time in 2021, as a 6% increase from 2020 pushed emissions to 36.3 gigatonnes (Gt)
- Emissions from the world's power plants reached their highest ever level as the biggest increase in CO<sub>2</sub> emissions by sector in 2021 took place in electricity and heat production since the use of all fossil fuels increased to help meet electricity demand growth
- Coal accounted for over 40% of the overall growth in global CO<sub>2</sub> emissions in 2021, CO<sub>2</sub> emissions from coal increased to an all-time high in 2021, and stood at 15.3 Gt

## growth rate of energy and process CO<sub>2</sub> emissions 2020-21 (Mt CO<sub>2</sub>)



## The developed world should shoulder greater responsibility in tackling climate change

- **Developed countries should shoulder more responsibility:** As per the United Nations Framework Convention on Climate Change, the developed world should bear a greater financial responsibility in tackling climate change and bear more financial obligations. The US and EU should deliver on the \$100 billion climate finance commitment to developing countries.
- **Fair and reasonable reduction in emission standards:** The climate change targets set forth by the developed world suggests the privilege of higher carbon emissions per person in these nations. For example, the US President Biden has set a 50-52% reduction target in carbon emissions by 2030 from levels witnessed in 2005. As per Emission Database for Global Atmospheric Research (EDGAR), the United States' per capita carbon emissions stood at 19.75MT. Even a 50% reduction from these levels suggest that the US's per capita emissions in 2030 would be nearly 2.2x the current world average. Developed countries are not in a position to poke their noses into emerging countries or set up trade barriers such as carbon tariffs under the pretext of climate change.
- **Climate finance mechanisms:** A report by the Adaption Gap suggests that there is an urgent need to Climate Adaption Finances. The estimated adaption cost was found to be 5-10 times higher than the present public adaption finance flows. Notably, this gap was found to be widening because of increasing adaption costs. Moreover, only 20% of the money pledged by the developed nations has been spent on climate adaption.
- **Increase technical and financial support:** With 2022 already set to become one of 10 warmest years on record, there is a dire need of increased technical and financial support to combat climate change. In this matter, precision agriculture practices would help in reducing carbon emissions and save soil and water biodiversity.
- **Stabilize the global supply chain of new energy.** Stabilize the global supply chain of new energy: Solar is one of the most important sources of renewable energy as of today. As per IEA, annual additions of solar PV capacity around the world need to be increased 4 times by 2030 to be on track with IEA's pathway of reducing carbon emissions. Notably, China is the leading investor in solar energy. However, recent issues amidst suppressing photovoltaic supply in Xinjiang and other regions can be detrimental to the climate.

## Exploration on Pakistan's response to Climate Change



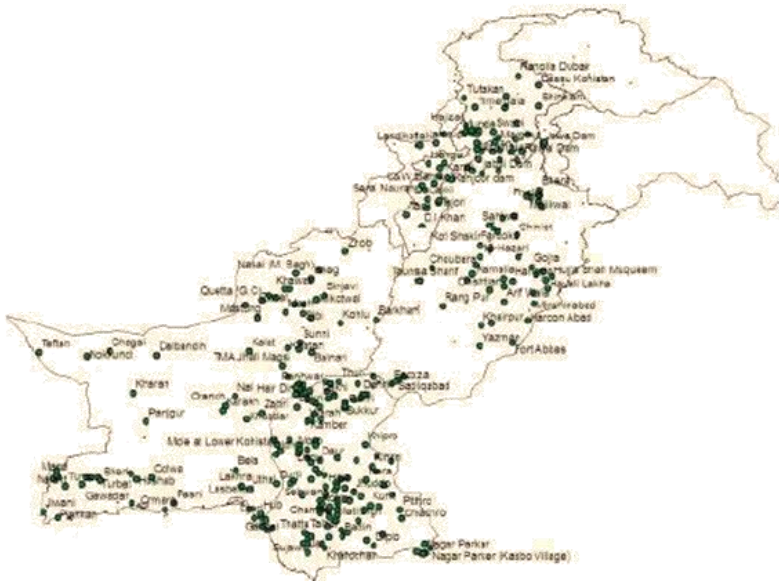


# Preventative Measures Against Droughts

National Drought Monitoring Center has been established to issue early warnings and monitor the drought situation across the country to help prevent the damages from drought

- After the severe consequences of the 1999-2001 drought in Pakistan, Pakistan Meteorological Department (PMD) took the initiative to establish the National Drought/Environment monitoring and Early Warning Centre (NDMC) in 2004-05
- Its main objective was to monitor the drought situation in the country and issue warnings beforehand for any potential upcoming drought
- NDMC has installed 335 Ordinary Rain gauges at the district level across the country
- NDMC uses different indices like Standardized Precipitation Index (SPI), Normalized Difference Vegetation Index (NDVI), Cumulative Precipitation Anomaly (CPA), Rainfall Anomaly Index (RAI), Percent of normal, Probability of occurrence, Percentage departure and soil moisture analysis to monitor drought

Rain gauges Installed Across the Country



Location	No. of Rain Gauges Installed
Balochistan	82
Punjab	83
KPK	42
Sindh	128
Pakistan	335

Source: [Pakistan Meteorological Department](#)

# Preventative Measures Against Flood

Pakistan Meteorological Department has set up the Flood Forecasting Division to deliver timely updates on the river flow and issue an early warning of any potential upcoming floods

- The Flood Forecasting Division (FFD), Lahore is a specialized unit of the Pakistan Meteorological Department (PMD) that has the function of forecasting the flood and issuing early warnings to the concerned departments
- The FFD provides an updated status of the river flow across the country, and for providing these updates, it sources the hydro-meteorological data from various National and International sources (Esri, HERE, Garmin, FAO, NOAA, USGS)
- The FFD analyzes this data to produce weather/flood forecasts & warnings that are communicated to relevant Federal/Provincial organizations through various means and disseminated through various social media platforms to inform the general public
- Moreover, under the “National Flood Protection Plan-IV (2015-2025)” the following preventative measures were also introduced:

Strategy	Measures
Reducing Flood	Watershed Management
	Dams and Reservoirs
	High flow diversion
	Channel improvement
Reducing Susceptibility to Damage	Flood Forecasting and Early Warnings
	Strengthening of existing rain and river gauging network
	Flood regulation
	Construction of flood protection and river training works i.e. levees, dikes, spurs, etc.
Mitigating the Flood Impacts	Information and education
	Disaster preparedness
	Post- flood recovery
	Flood insurance

## Live Updates on River Flow



●	Normal Flow
●	Low Flood
●	Medium Flood
●	High Flood
●	Very High Flood
●	Exceptionally High Flood

Source: [Flood Forecasting Division](#)

# Introduction of Electric Vehicle Policy to Curtail GHG/Carbon Emission

## Promoting the use of Electric Vehicles to curtail the GHG/carbon emission and greenhouse gases

- Introduction of the EV policy would help lower the carbon/greenhouse gases emission (GHG) and could be considered as Pakistan’s role in preventing the climate changes
- The Government of Pakistan introduced an Electric Vehicle policy at the end of 2021
- Under this policy, the government had set the minimum mandatory electric vehicle (EV) penetration targets with the objective of mitigating climate change through a reduction in emissions from the transport sector
- As per the targets policy, 30% of new car sales would be electric vehicles by 2030 and the target was to reach 90% by 2040
- This initiative reflects net benefits in the range of US\$ 2.2 billion to US\$ 3.7 billion as net savings in oil bills to the country under different scenarios in the 2020 to 2030 time period
- The cost saving from the policy is shown in the table on the right side. The socio-economic cost of carbon ranges between USD15-USD100 per metric ton for developing countries. However, it assumes USD 50 per metric ton as a standard for Pakistan which is a conservative estimate due to the fact that Pakistan is one of the most affected countries by climatic changes



Socio-Economic Savings as per EV Policy 2021

Vehicles	Socio-Economic Cost of Emission
Cars	USD 22.9 Mn
2/3 Wheelers	USD 66.4 Mn
Buses	USD 1.7 Mn
Trucks	USD 2.1 Mn
Total	USD 93 Mn

Source: [EV Policy](#)

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## China's solutions to climate change are more compatible with the conditions in emerging countries

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- We think China's solutions to climate change are more feasible for countries such as Pakistan. China's status as a developing nation allows it to relate to the realities of other developing countries and formulate a more suitable and effective plan for tackling climate change.
- China has overcome its own economic and social difficulties, adhered to the path of green and low-carbon development, implemented a national strategy to actively address climate change, continuously improved its efforts to address climate change, strengthened its independent contribution goals, and accelerated the construction of carbon peaks. , carbon neutral "1+N" policy system, implement synergistic governance of pollution reduction and carbon reduction, actively explore new models of low-carbon development, and make tangible contributions to promoting global climate governance and addressing climate change.
- Since 2011, China has allocated a total of 1.2 billion yuan for South-South cooperation on climate change. It has donated energy-saving and new energy products and equipment to nearly 40 countries, help relevant countries build low-carbon demonstration zones, launch meteorological satellites, install solar panels, produce EVs, etc. It has trained about 2,000 officials and technicians in the field of climate change response for 120 developing countries.
- Pakistan, China to launch Green Corridor, which will focus on agricultural environment, food security, and green development.

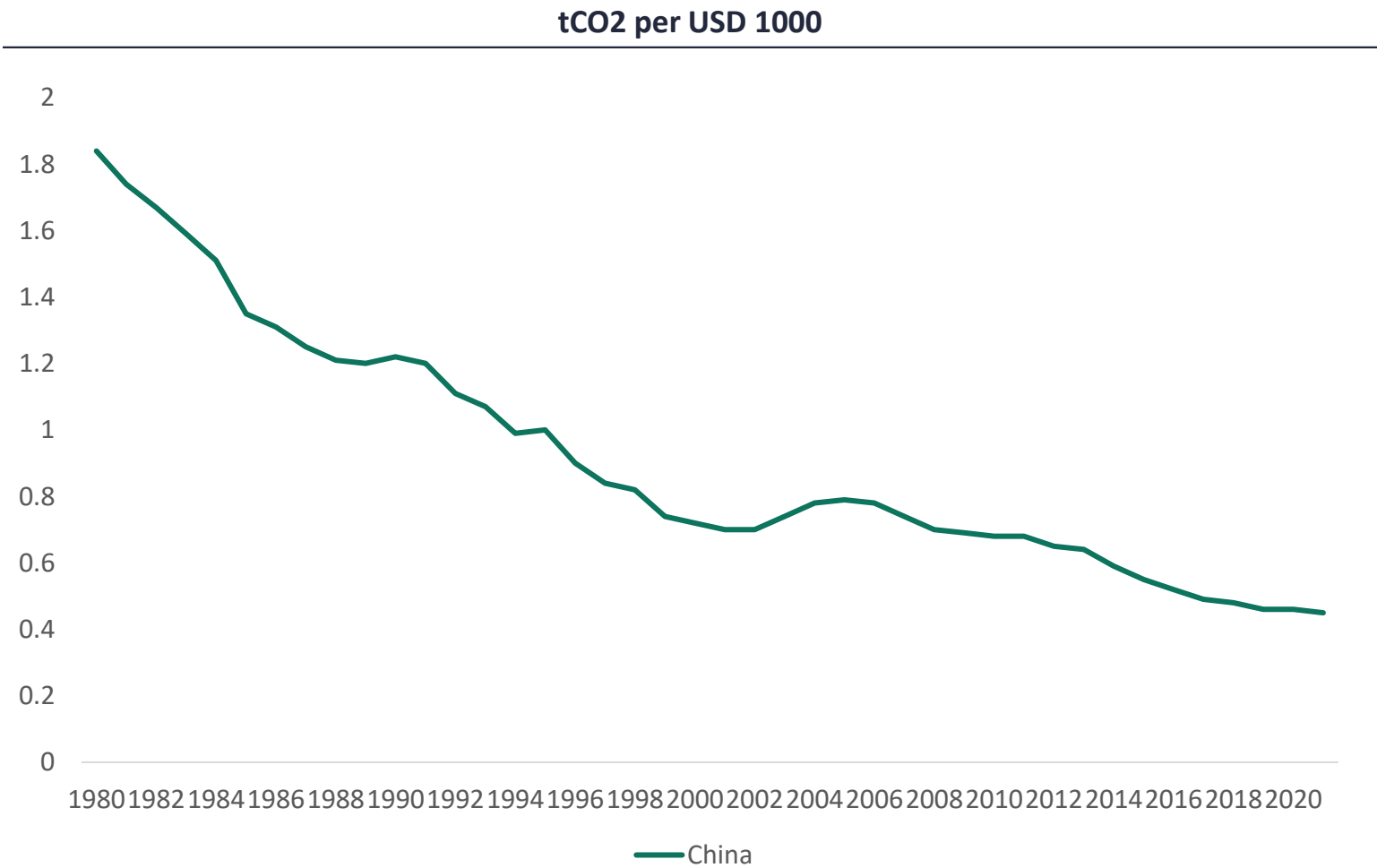


# China Shows Prominent Progress Towards Reducing CO<sub>2</sub> Emission

China has been the pioneer in the renewable energy industry, and its focus on clean energy innovation has helped China to achieve a sustainable growth as compared to other countries

## China’s Focus on Clean Energy Innovation

- During the last 2 decades, China has marked its position on the global stage as an energy innovator. In 2021, China's CO2 emissions per unit of GDP decreased by 50.8% compared with 2005
- This can be warranted from China’s dominance of solar power industry and, more recently, electric mobility in China as the country became the world’s manufacturing powerhouse for several key energy technology areas, such as solar photovoltaics (PV), wind turbines and batteries for electric vehicles (EVs)
- The success is a result of several decades of increasing policy focus on technology innovation, which highlights China’s goal to be recognized as a producer of knowledge and foster innovation-driven socio-economic development
- China’s progress in reducing CO2 emission is driven by its focus towards clean energy innovation, which will further play a crucial role to achieve China’s objectives of carbon peaking by 2030 and neutrality by 2060



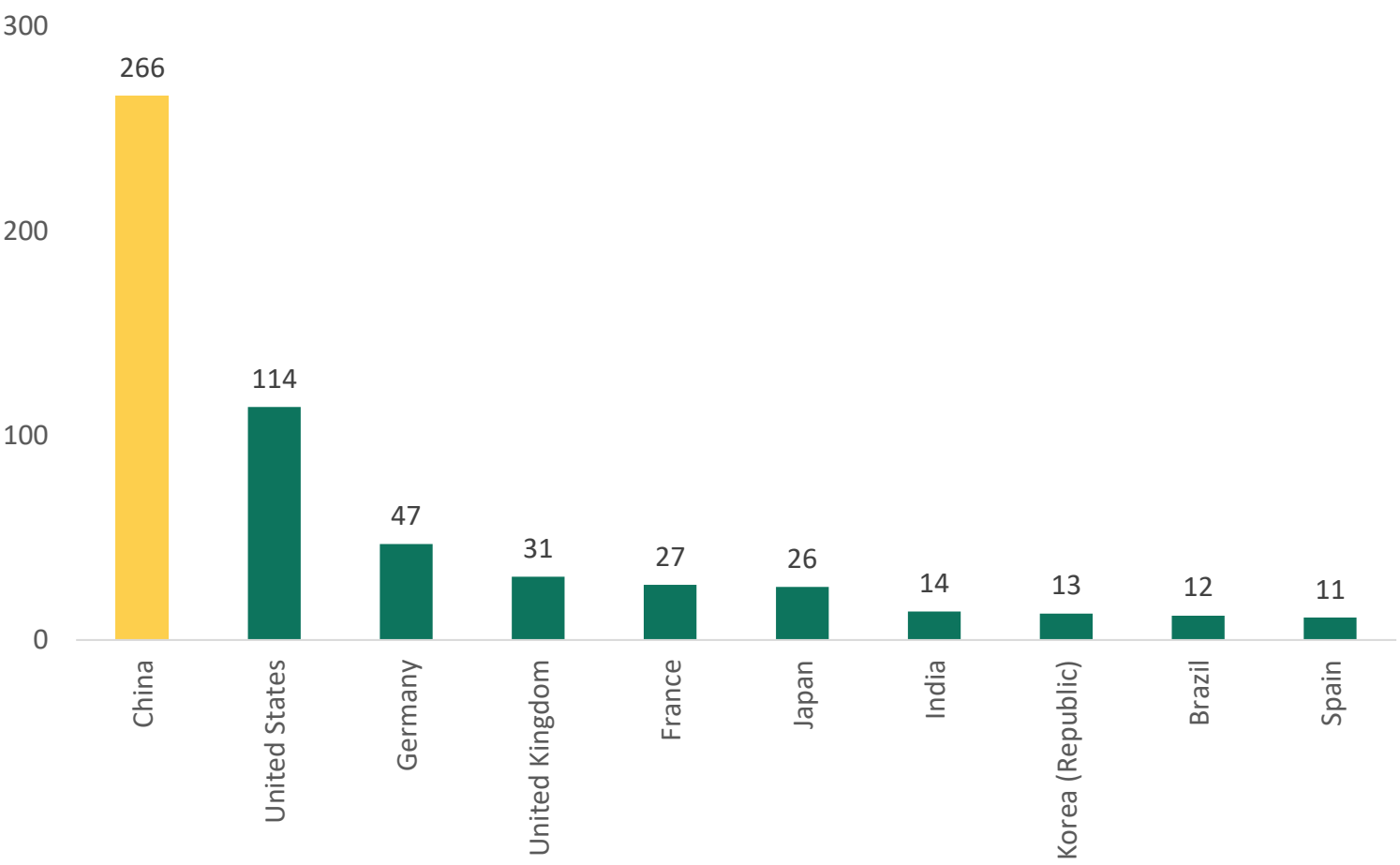
# China has been the Most Active in Energy Transition

China has been promoting the use of energy efficiency across various sectors to meet its target for lower carbon emission.

## Improving Energy Efficiency

- China has placed initiatives under the National Plan on Climate Change 2014-2020 for energy efficiency
- In the plan, the following were targeted:
  - Urban green buildings should account for 50% of the proportion of new construction by 2020
  - The share of bus travel in large and medium-sized cities should reach 30% by 2020
  - Control the expansion of high energy consumption industries, and high emission industries
  - Promote energy efficiency in commercial and civil, agricultural and rural areas as well as public institutions
  - Construct energy-efficient and low-carbon energy supply infrastructure

Global Investment in Energy Transition by Country, 2021 (\$ billion)



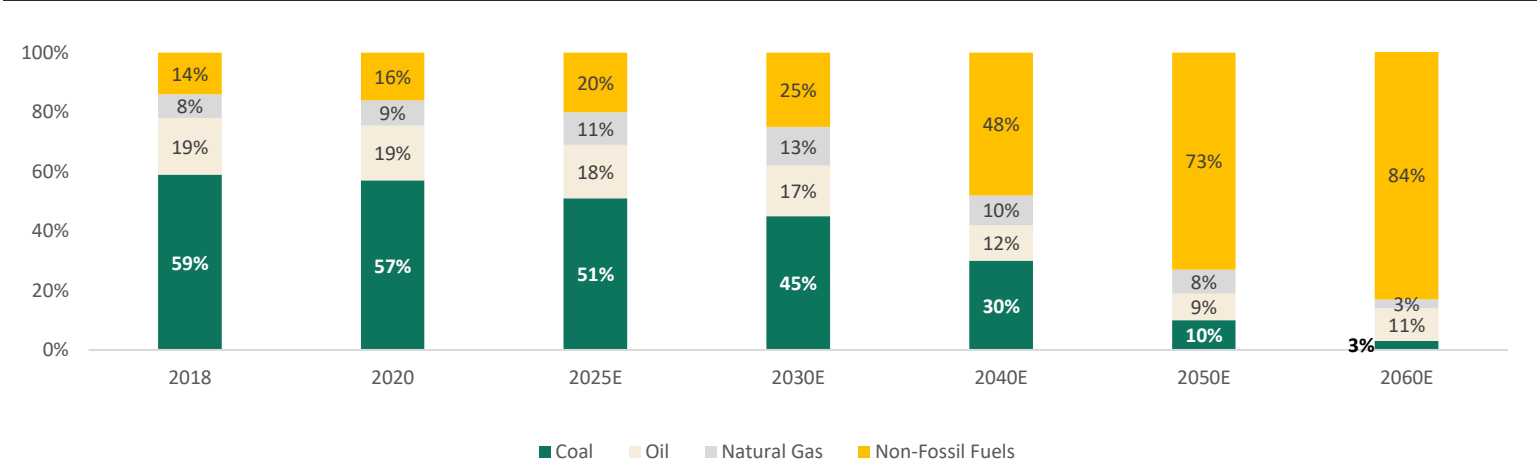
# How is China Planning to Lower its Carbon Emission? (1/3)

China aims to reduce its dependence on coal consumption as means of energy and power generation over the next 4 decades

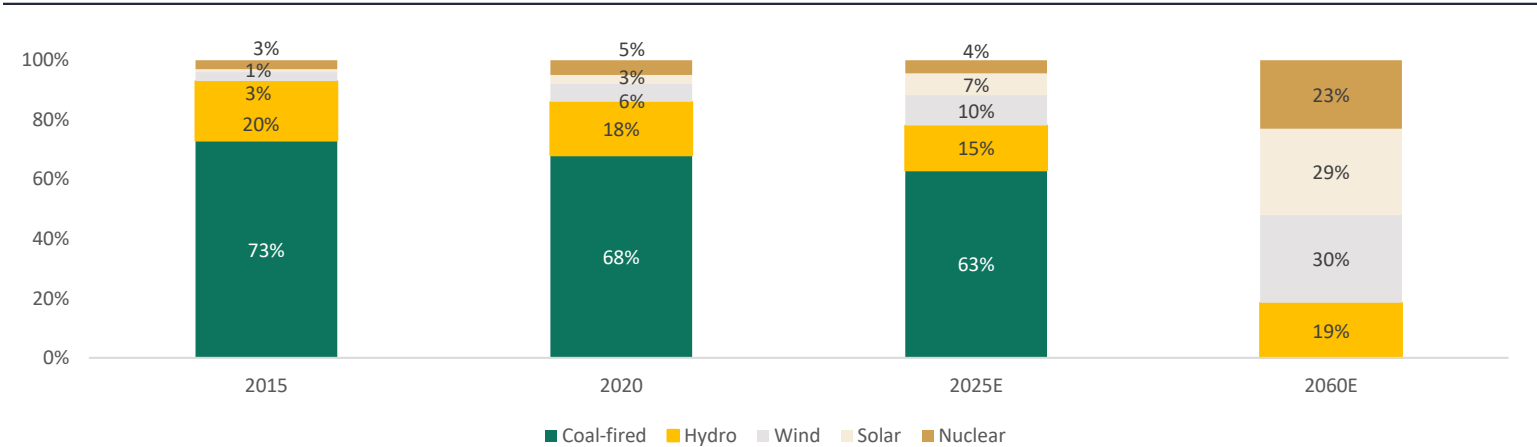
## Cutting Coal Consumption

- The Chinese government aims to reduce its coal consumption and hence it has introduced the following policies and programs for achieving this goal:
  1. Five-Year Plan targets for limiting coal use
  2. Programs to phase out coal heating in much of northern China
  3. Programs to shut down inefficient coal power plants, boilers, and furnaces
  4. coal power plant efficiency standards
  5. market-based reforms that weaken coal’s historic dominance in power generation
- Currently, China’s energy mix remains heavily skewed towards coal (57% in 2020) but according to China’s 14<sup>th</sup> five-year plan, the Country aims to decrease the share of coal to 51% by 2025 and to 45% by 2030. The plan aims to increase the share of non-fossil share to around 20% by 2025 and to 25% by 2030

## Energy Mix Forecast in China



## China’s Power Generation Mix by Fuel





# How is China Planning to Lower its Carbon Emission? (2/3)

The Chinese government has been promoting the use of environment-friendly renewable energy sources to reduce its carbon emission

## Deploying Low-Carbon Power

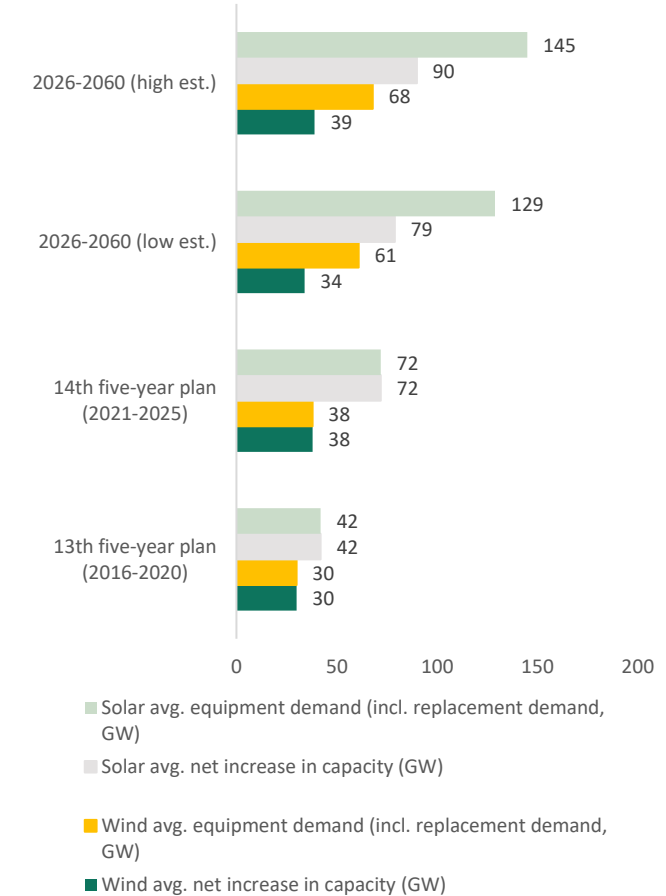
- The Chinese government has been promoting the use of solar power, wind power, hydropower, and nuclear power
- The policies government has implemented for this purpose are as follows:
  1. Five-Year Plan targets with ambitious deployment goals
  2. Generous feed-in tariffs for wind and solar power
  3. Requirements that grid companies purchase minimum amounts of renewable power
  4. Help assemble land and arrange for transmission connections at new nuclear power plant sites
  5. Cheap debt capital and waivers of dividend payments for the state-owned companies developing nuclear power plants

## Global Annual Solar Capacity Installation (MW)

Year	China	Rest of the World	Total
2015	34,870	15,130	50,000
2016	42,460	34,540	77,000
2017	50,900	53,100	104,000
2018	58,740	44,260	103,000
2019	84,900	30,100	115,000
2020	81,800	48,200	130,000
2021	115,250	54,750	170,000
2022E	130,000	80,000	210,000
2023E	160,000	100,000	260,000
2024E	180,000	120,000	300,000
2025E	200,000	130,000	330,000

Source: IEA, CPIA, PVInfoLink, Citi Research Estimates

## Renewable Capacity Addition



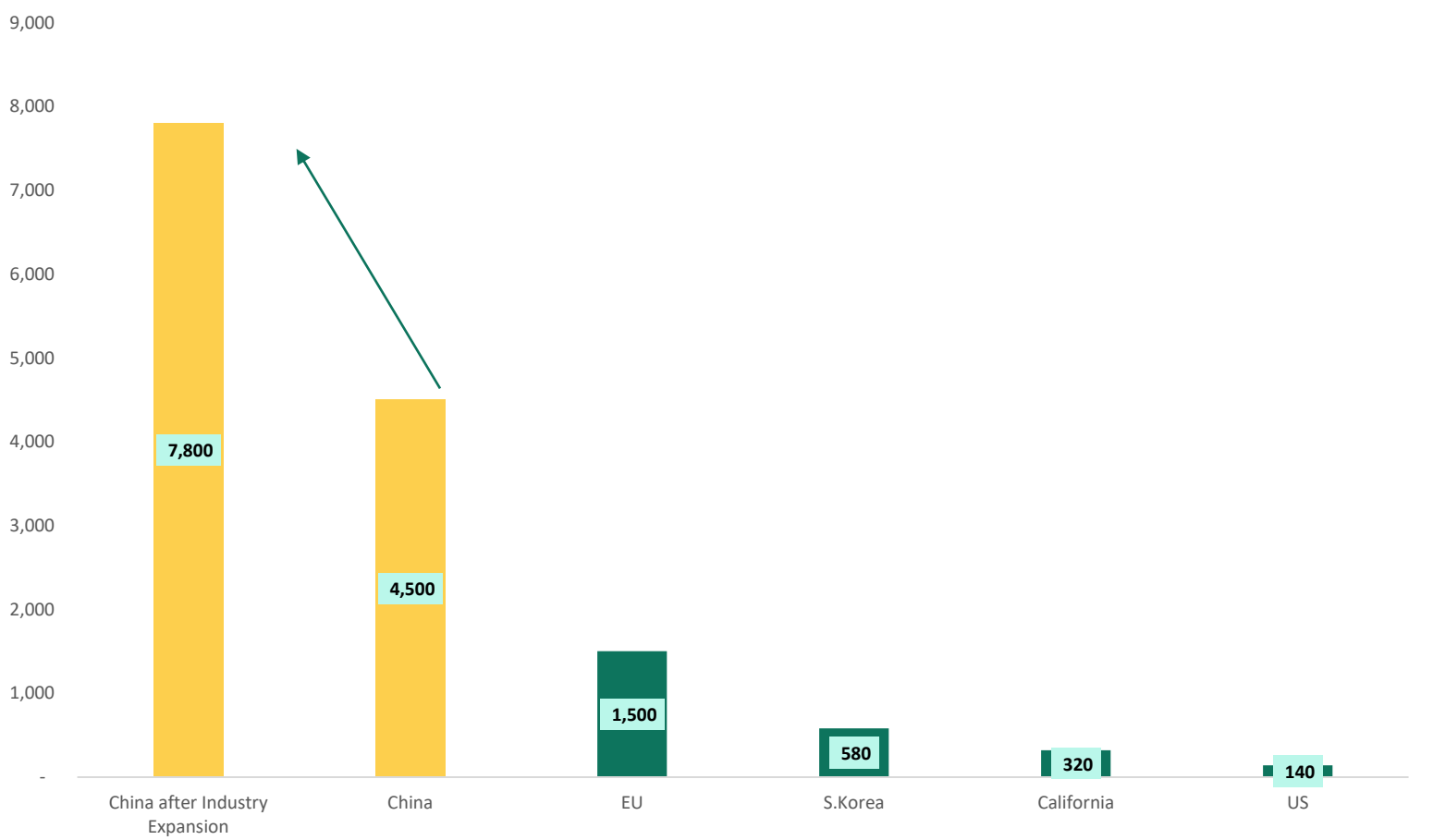
# How is China Planning to Lower its Carbon Emission? (3/3)

China is expanding the number of industries under the carbon emission trading market; this would increase the size of the Chinese Emission Trading Scheme (ETS) Market and hence eventually help in carbon emission reduction

## Establishing Carbon Markets

- Since Carbon trading is an important instrument for internalizing the external costs of air pollution and eventually lowering carbon emission, China started the operation of a national ETS in 2021
- The national ETS covers more than four billion tCO<sub>2</sub> from the power sector (approx. 40% of national emissions) and is expected to be a key policy instrument to achieve the country’s climate ambition
- The scheme is set to be further developed over time, for instance, be rolled out into other industry sectors over time and introducing additional trading instruments such as carbon derivatives
- China’s ETS is expected to formally include six additional industries which are iron and steel, aluminum, cement, chemicals, papermaking, and civil aviation by 2025
- Therefore, China’s ETS is about to grow 70 percent under plans to add heavy industry and manufacturing

## Emission Trading Schemes Across the World Mt (million metric tonnes of CO<sub>2</sub>)



Source: [Energy Innovation](#)

## **MoU with Elion Resources Group Co.**

- In 2021, the Ex-Prime Minister of Pakistan, Imran Khan signed an MoU with Elion Resources Group to establish China-Pakistan Ecological demonstration zone in Pakistan with an approximate cost of USD 5 million.
- The zone shall be developed to demonstrate desertification control based on Kabuqi model successfully implemented in China

## **Shanghai Cooperation Organization (SCO)**

- (SCO) is a political, economic, and security alliance created in 2001, comprising of China, India, Kazakhstan, Kyrgyzstan, Russia, Pakistan, Tajikistan, and Uzbekistan
- SCO holds expert group meetings of Expert Group meetings of SCO Member States responsible for environmental protection. Ecological Wellbeing of the Cites in SCO region are part of these events

## **China's Support for Pakistan Agriculture Sector after Flood**

- The China Machinery Engineering Corporation (CMEC) has recently shown keen interest in setting up an Agriculture, Science and Technology Transferring Center in Pakistan to boost cooperation in agriculture mechanization for the improvement of crops' yield and seeds' quality in the country
- Pakistan Agricultural Research Council (PARC) and Chinese Yunnan Academy of Agricultural Sciences (YAAS) signed a memorandum of understanding (MoU) to promote agricultural cooperation between Pakistan and China



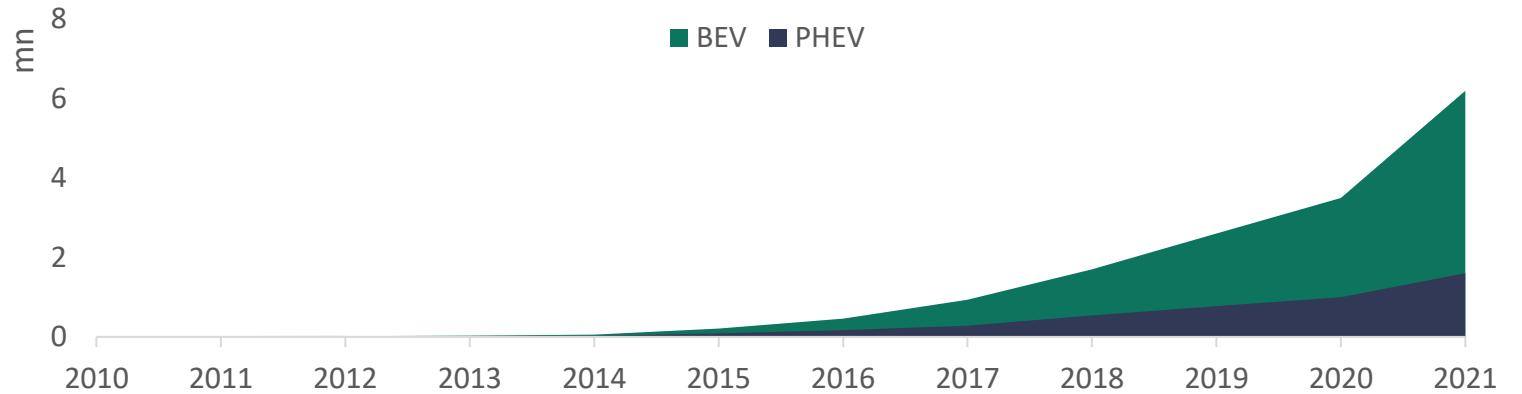
# How can Pakistan Cooperate with China to Reduce Climate Change? (1/3)

Since China has been experiencing high growth in the EV sector, China could leverage its technology in Pakistan's transportation sector to reduce greenhouse gases emission in Pakistan.

## Lower Carbon Emission through EVs

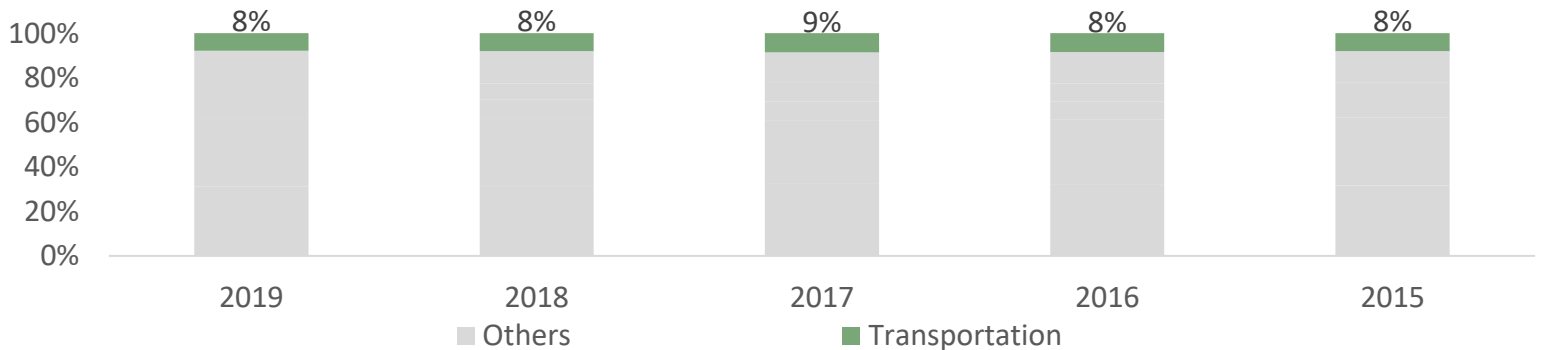
- Globally transportation sector is considered among the highest contributors to carbon emissions.
- In 2019, transportation accounted for ~12055 MtCO<sub>2</sub>e out of the world's total ~49758 MtCO<sub>2</sub>e carbon emission. ([Climate Watch Data](#))
- Similarly, Pakistan also has a contribution from the transportation sector in GHG emission
- China has experienced exponential growth in the EV industry with a 5-year CAGR being around ~45% (2017-2021)
- China could leverage its EV technology in Pakistan in an effort to reduce greenhouse gases emission from the transportation sector
- Moreover, Pakistan has recently also introduced an EV policy to combat the greenhouse gases emission from transportation

## Exponential Growth in EV Production in China over the last 5 years



Source: [IEA](#)

## Transportation is a Significant GHG Emitting Sector in Pakistan



Source: [Climate Watch Data](#)

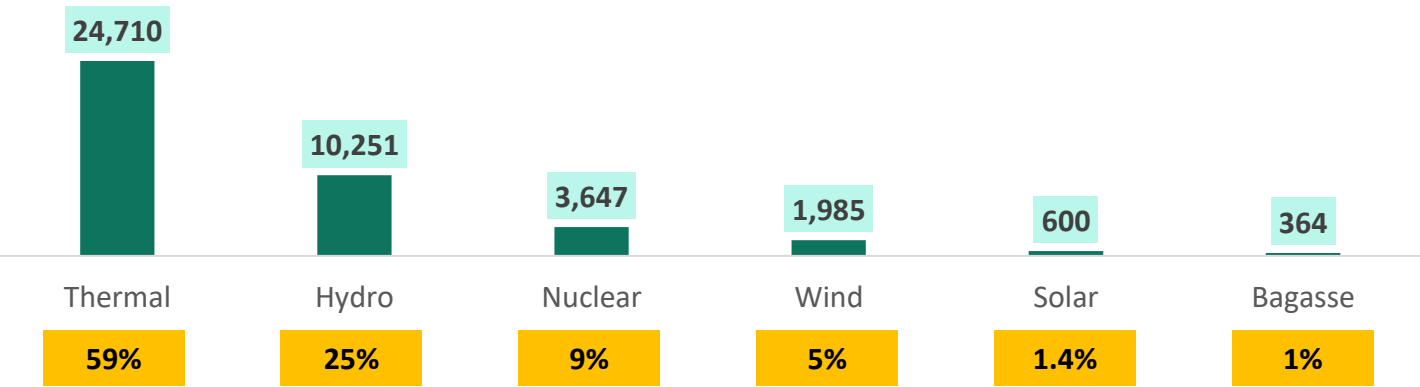
# How can Pakistan Cooperate with China to Reduce Climate Change? (2/3)

China, being a significantly large player in the solar industry, could help Pakistan develop its renewable energy sector

## Supporting the Renewable Energy Sector

- China has around 68% (115,250 MW) of the installed global solar capacity (170,000)
- However, Pakistan’s power generation from solar is significantly smaller and China could help Pakistan develop its renewable energy sector
- At present, Pakistan’s installed power generation capacity from solar accounts for just 1.4% (600 MW) of the total installed power generation capacity
- CEO of AEDB<sup>1</sup>, mentioned that “Pakistan has a target to generate 10,000 MW of renewable energy. Pakistan required USD 6 bn investment to achieve this target and Chinese companies and banks are best suited to finance these projects as they have already been working in Pakistan for various Power Projects”

## Pakistan’s Installed Power Generation Capacity – (Megawatt – MW) – 2022



Source: [NEPRA State of The Industry Report](#)

## Planned Forecasts for 2030 – Installed Capacity MW



Source: NEPRA Approved IGCEP September 2021

Source: <sup>1</sup>Tribune, Chinese firms can invest \$6b in ARE (2022). URL: [Chinese firms can invest \\$6b in ARE \(tribune.com.pk\)](#)

# How can Pakistan Cooperate with China to Reduce Climate Change? (3/3)

**Pakistan is highly dependent on the agriculture sector and climate change will significantly affect this sector; Pak-China cooperation could help Pakistan counter the climate change impact on the agriculture sector**

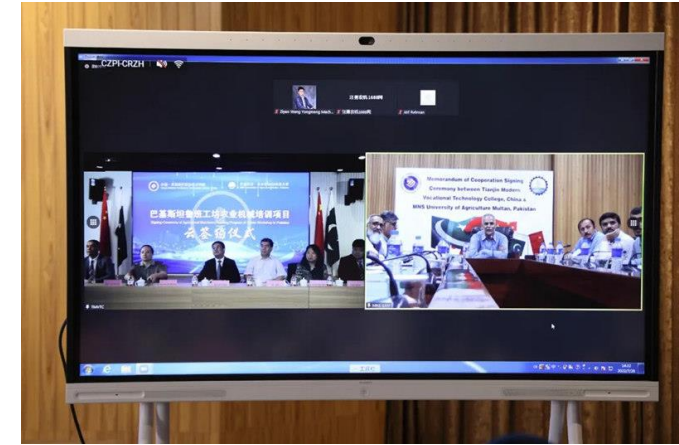
## Pak-China Agri Cooperation

- According to an official study (2020-2021), there will be a significant decrease in the agricultural yield, due to the increasing trend in temperature, of around 6 percent decrease in the yield of wheat, and around 15-18 percent decrease in the yield of rice across Pakistan
- There is a potential for China to cooperate with Pakistan in diverse sectors of agriculture production that can help with water conservation, cultivation of hybrid crops, and other scientific cooperation to counter the challenges faced by climate change
- Pakistan Agricultural Research Council (PARC) and the Chinese Yunnan Academy of Agricultural Sciences (YAAS) signed a memorandum of understanding (MoU) to promote agricultural cooperation between Pakistan and China

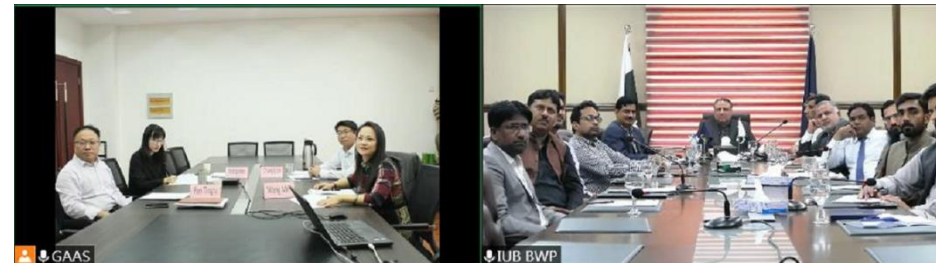
## MOU Between (TMVTC, China) and (MNS, Multan) to gear up for agricultural cooperation

Tianjin Modern Vocational Technology College (China) and MNS-University of Agriculture (Multan, Pakistan) signed online an agreement for an agricultural machinery training program of Luban Workshop in Pakistan on July 28, 2022.

Source: [Gwadar pro](https://www.gwadar.pro)



## Gansu to share agricultural expertise with Pakistan



Gansu Academy of Agricultural Sciences (GAAS) and the Islamia University of Bahawalpur (IUB) discussed a roadmap for boosting agricultural cooperation in the future, with advanced Chinese technologies to be transferred to Pakistan.

Source: [Gwadar pro](https://www.gwadar.pro)



The End.

