Pakistan Academy of Engineering

16th Symposium: **"Climate Change & Capture of CO_2"**

held on February 29, 2019 at, Mövenpick Hotel, Karachi.

Address of the President,
Dr. Ing. Jameel Ahmad Khan

Honourable Advisor to the Prime Minister

On Climate Change**,** Malik Amin Aslam Khan!

Learned Speakers!

Distinguished Guests!

Fellow Engineers!

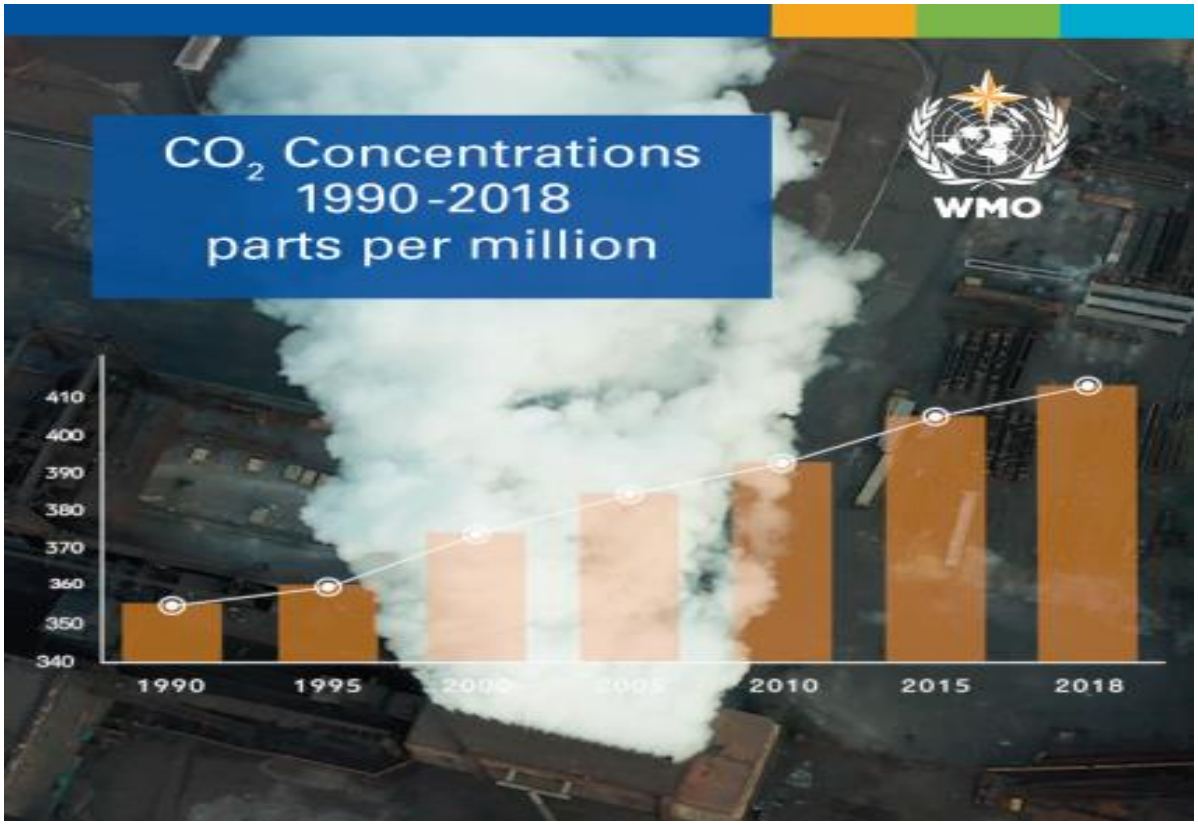
Ladies & Gentlemen!

SALAMUN ALA MANI T-TABAUL-HUDA

May I welcome you this morning most sincerely and warmly to participate in an event that is of highest interest to all of us. Your continued cooperation is highly encouraging for us.

Ladies & Gentleman!

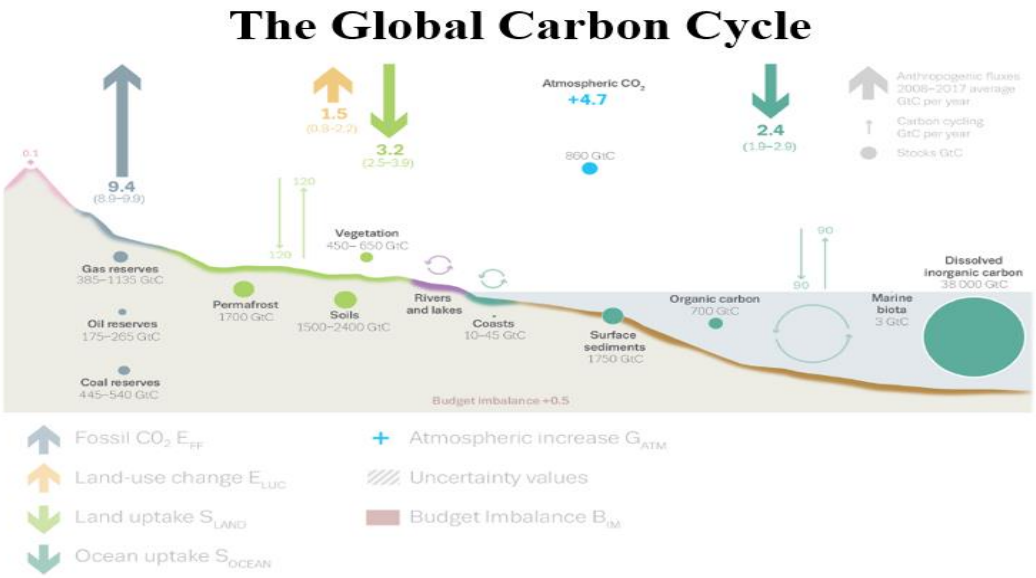
The WMO Greenhouse Gas Bulletin On November 25, 2019 alerted us that globally averaged concentrations of carbon dioxide (CO2) reached 407.8 parts per million in 2018, up from 405.5 parts per million (ppm) in 2017.



[Slide 1]

Since 1990, there has been a 43% increase in total radiative forcing – the warming effect on the climate - by long-lived greenhouse gases.

Let us first understand the Global Carbon Cycle.

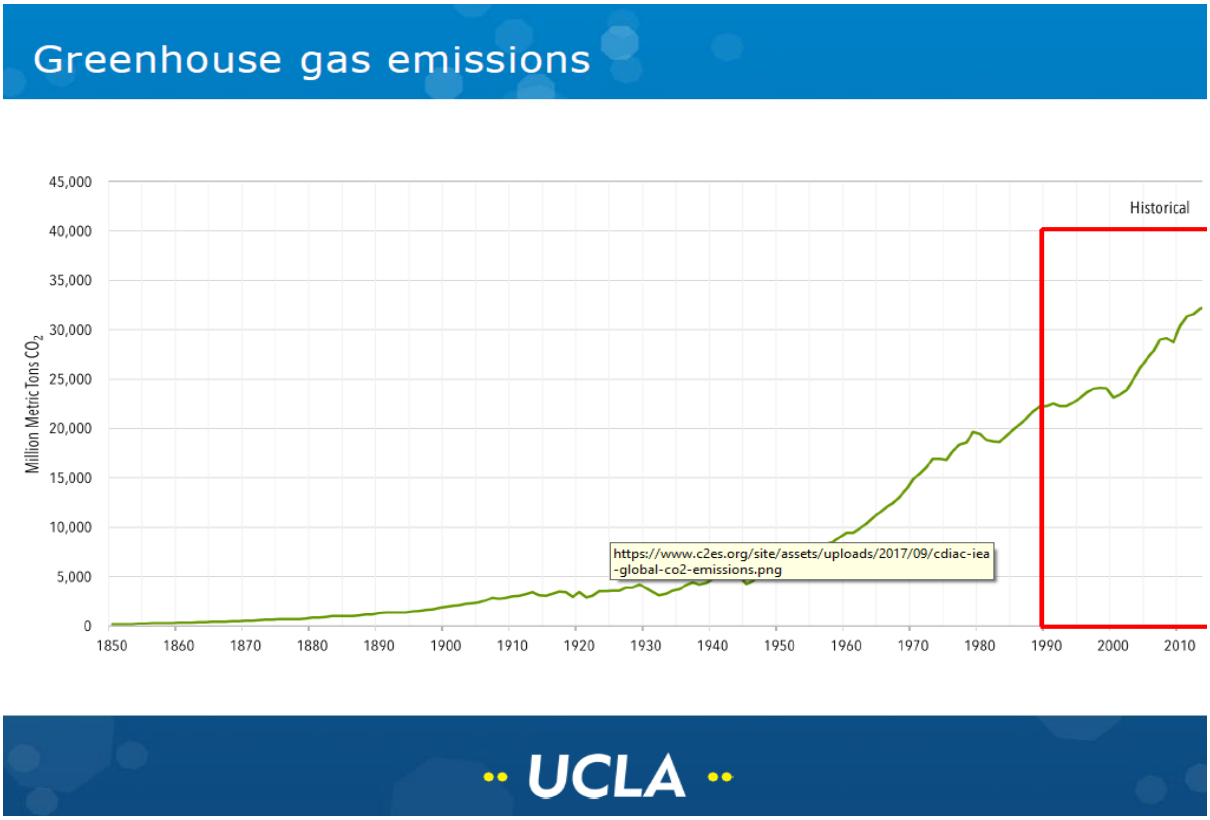


Schematic representation of the overall perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2008–2017. See legends for the corresponding arrows and units. The uncertainty in the atmospheric CO_2 growth rate is very small ($\pm 0.02\ GtC\ yr^{-1}$) and is neglected for the figure. The anthropogenic perturbation occurs on top of an active carbon cycle, with fluxes and stocks represented in the background and taken from Ciais et al. (2013) for all numbers, with the ocean fluxes updated to $90\ GtC\ yr^{-1}$ to account for the increase in atmospheric CO_2 since publication, and except for the carbon stocks at the coasts, which are from a literature review of coastal marine sediments (Price and Warren, 2016).

[SLIDE 2]

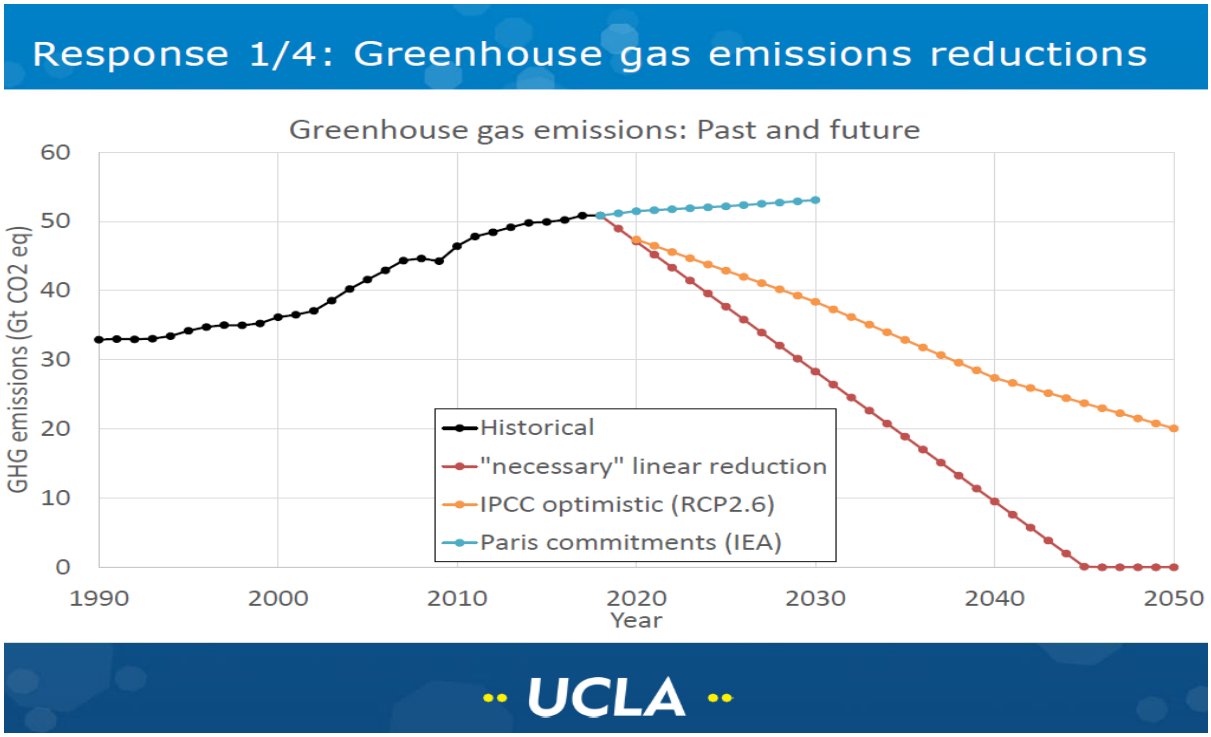
The Paris Agreement of twelfth day of 2015 is the vehicle for addressing Climate Change. The international community (194 countries) pledged to work for the goal of limiting the global temperature rise to less than 2° C.

The concentration of CO_2 in the atmosphere has increased from 277 ppm in 1750, pre-industrial era, to 405 ppm in 2017.



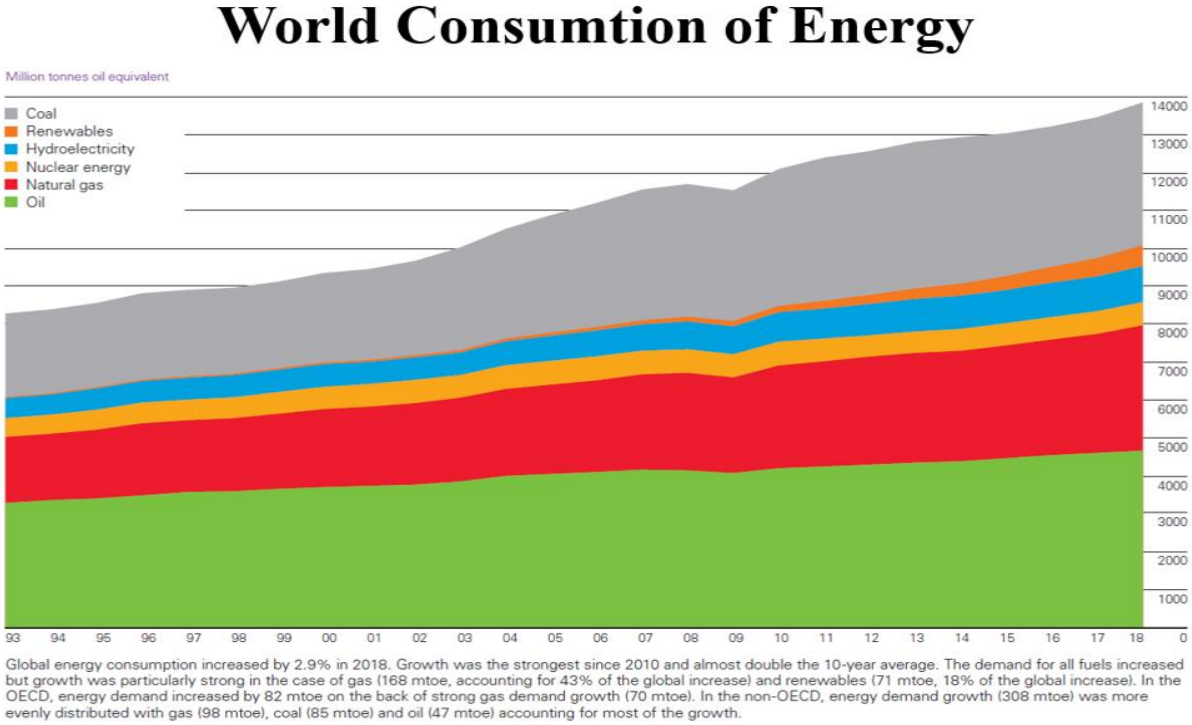
[Slide 3]

About 40 Gt of CO_2 is emitted from worldwide energy use per year. The amount used economically is less than 1%. The concentration of CO_2 in the atmosphere is very dilute, about 0.04%. CO_2 should be kept out of the atmosphere for thousands of years or more. Each year only about half the amount of CO_2 we emit to the atmosphere stays there.



[Slide 4]

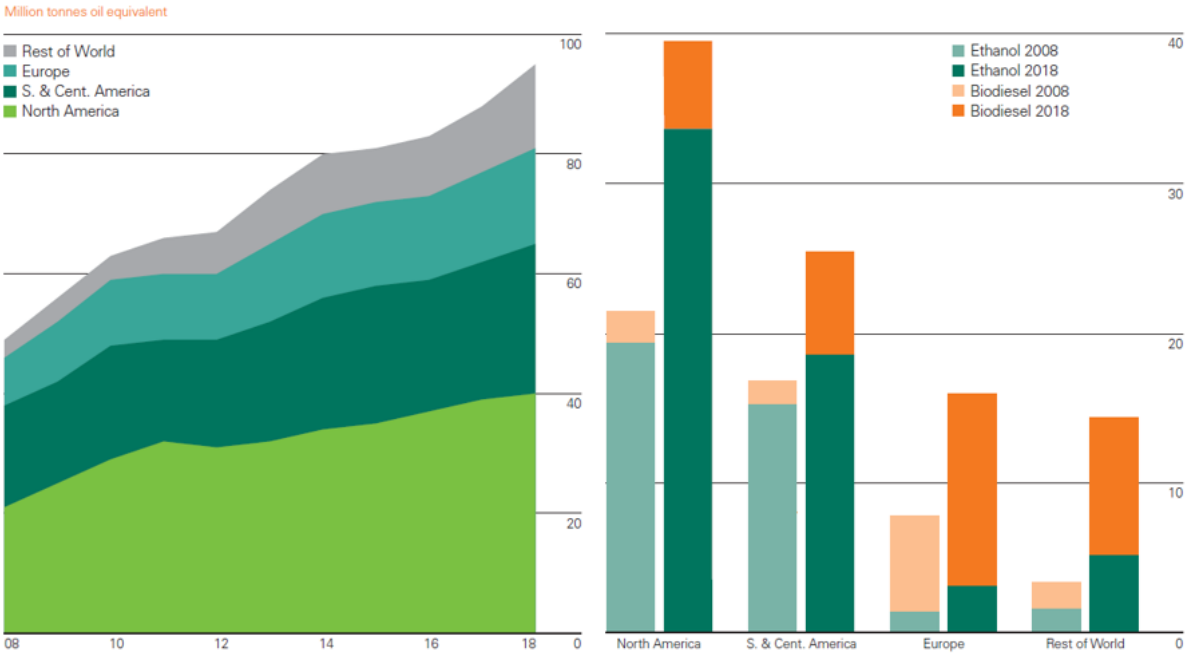
World Consumption of Energy shows that Coal, Oil and Natural Gas are the main culprits.



[SLIDE 5]

Biofuels production in the world does not significantly mitigate the problem.

World Biofuels Production



Biofuels production growth averaged 9.7% in 2018, the highest growth since 2010 and slightly above the 10-year average. Brazil (3.1 mtoe) and Indonesia (2.2 mtoe) together accounted for almost two thirds of global growth (8.5 mtoe). By fuel, ethanol production in 2018 totalled 60.4 mtoe with North America accounting for 56%. Biodiesel production in 2018 amounted to 34.9 mtoe with Europe representing 37%.

[SLIDE 6]

International Panel for Climate Change (IPCC) made an assessment for appropriate targets for the capture of CO_2:

Appropriate Targets for Capture of CO_2

- Coal fired plants - 60%
- Other power plants - 19%
- Cement - 7%
- Refineries - 6%
- Iron & Steel - 5%
- Petrochemicals - 3%

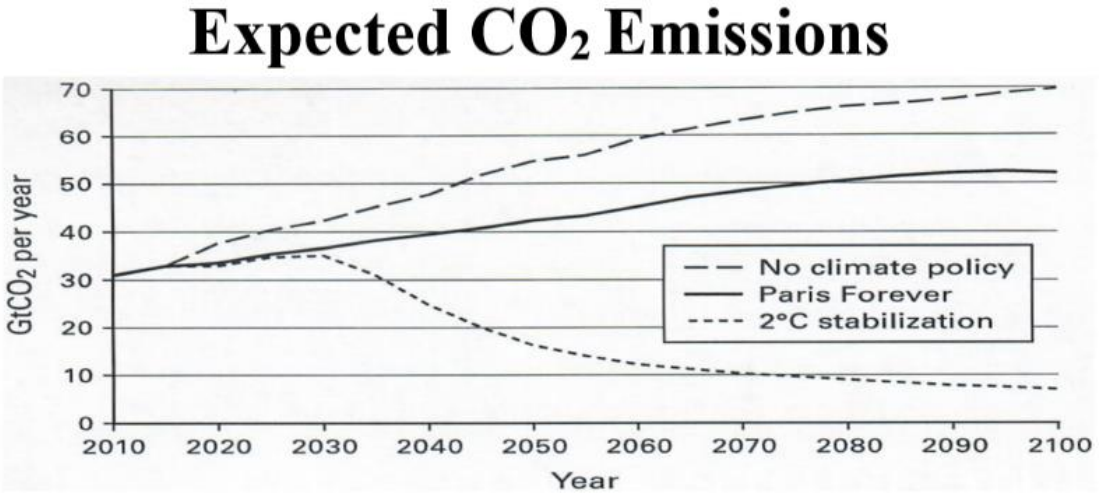
[SLIDE 7]

Agriculture crop and animal production systems are important sources and sinks for atmospheric methane (CH_4). The major CH_4 sources from this sector are ruminant animals, flooded rice fields, animal waste and biomass burning which total about one third of all global emissions.

Methane is a greenhouse gas that has a warming effect 28 times as powerful as Carbon dioxide. It will be interesting to learn that a cow has about the same greenhouse effect as a car. Cutting the emissions of methane of even a portion of the world's 1.5 bn cattle would

bring great benefit. The anti-methanogenic powers of Asparaguses, the seaweed, could be employed to feed the cattle in order to reduce methane belched by them.

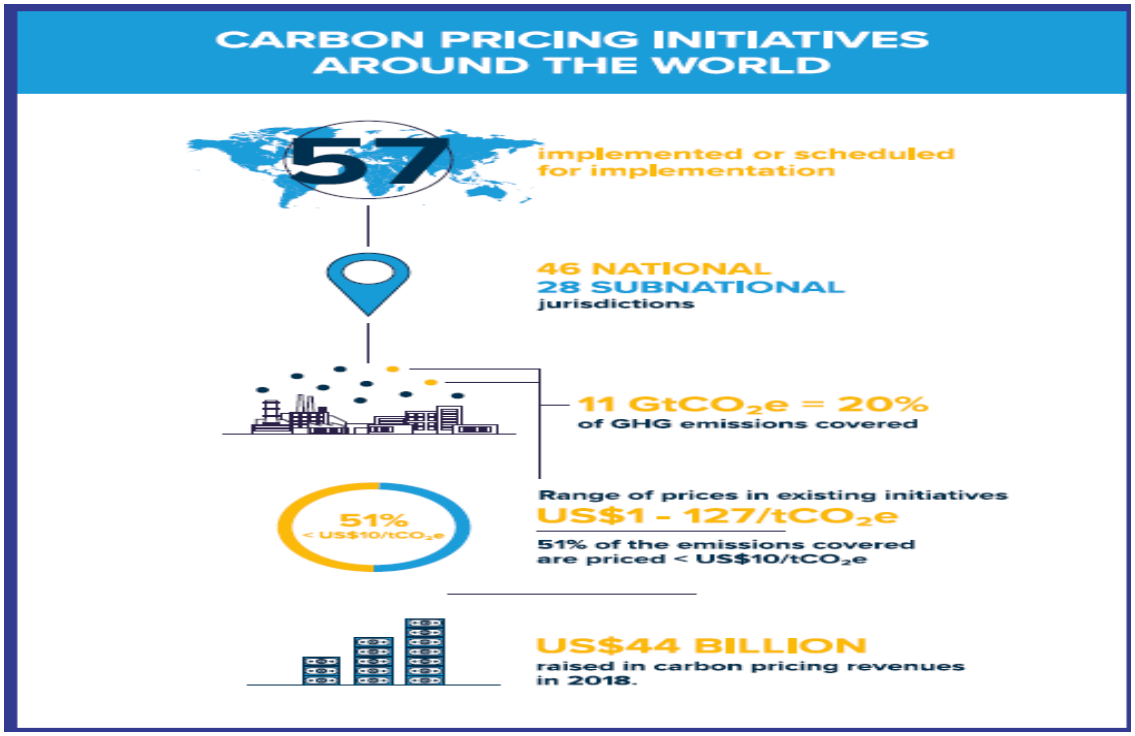
However, the expected scenario will be as depicted in the next slide.



[SLIDE 8]

In a recent article Randy Mac Ewen President & CEO of Ballard States: "Mobility is undergoing a profound transformation. It is now broadly recognized that the energy transformation required to limit global warming to 2^0 C (as agreed in the COP21 Paris Climate accord) must include the complete decarbonisation of mobility". It would require a massive shift from vehicles with internal combustion engines powered by gasoline and diesel, to zero emission electric vehicles.

Carbon Pricing is increasingly recognized as an essential instrument to cost-effectively deliver the transition to low-carbon societies.



[Slide 9]

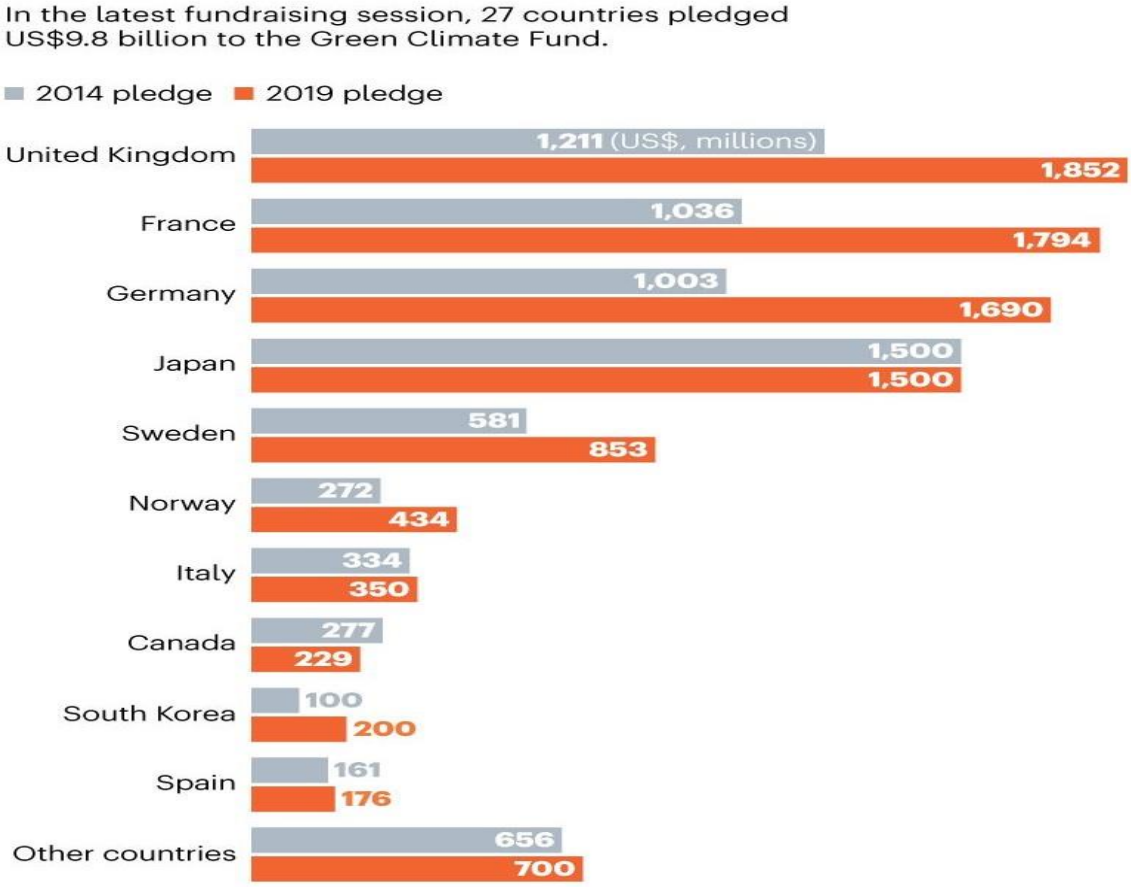
Article 6.2 of the Paris Agreement covers cooperation approaches, where parties could opt to meet their NDCS by using informationally transferred mitigation outcomes (ITMOs).

Article 6.4 establishes a mechanism for countries to contribute to GHG emission mitigation and sustainable development.

It is a pleasure to see a heading in the journal Nature Briefing of November 04, 2019, that Green Climate Fund attracts record pledges 27 countries have pledged US $ 9.8 billion to replace a United Nation's fund for developing nations to adapt to Climate Change.

We should be prepared to cash in the opportunity.

Climate Cash



[SLIDE 10]

Carbon Dioxide Capture and Utilization (CCU) is an alternative to storage technology (CCS). Bill Gates is an investor in Carbon Engineering, a Canadian Start-up to ramp up production of synthetic fuels, using the Captured Carbon Dioxide. Cline work of Switzerland has installed a direct air Capture plant in Italy to produce methane from Captured CO_2 and hydrogen. Global thermostat of New York finished its first Commercial plant in Alabama last year.

However, according to an important article published in Nation Climate Change of April 2007: "Owing to the scale and rate of CO_2 production compared to that of utilization allowing long-term sequestration, it is highly improbable that the chemical conversion of CO_2 will account for more than 1% of the mitigation challenge, and even a scaled-up enhanced oil recovery (EOR)-CCS industry will likely account for 4-8%. CCU may prove to be a costly distraction financially and politically, from the real task of mitigation:

Present and Short-term uses of CO_2 based on production data and forecasts

Compound	2013 production (Mt per year)	CO_2 used in 2013 (Mt per year)	2016 production forecast (Mt per year)	2016 forecast CO_2 needed (Mt per year)	Rate of growth of production (% per year)	Rate of growth of CO_2 utilization (% per year)
Urea	155	114	180	132	5	5
Methanol	50	8	60	10	7	8
Carbonates	0.2	0.005	2	0.5	300	3,300
Polycarbonates	4	0.01	5	1	8	3,300
Carbamates	5.3	0	6	1	4	-
Polyurethanes	8	0	10	0.5	8	-
Acrylates	2.5	0	3	1.5	7	-
Formic acid	0.6	0	1	0.9	22	-
Inorganic carbonates	200	50	250	70	8	13
Technological		28		80	0	62
Algae for biodiesel	0.005	0.01	1	2	6,633	6,633
Total	**426**	**200**	**518**	**299**	**7.2**	**16.5**

The final two columns of this table contain figures calculated by the authors using data presented in ref. 35.

Source: Nature Climate Change, April 2007

[SLIDE 11]

Since 1993, the rate of ocean warming has more than doubled. By absorbing more CO_2, the ocean has undergone increasing surface acidification. Global mean sea level (GMSL) is rising.

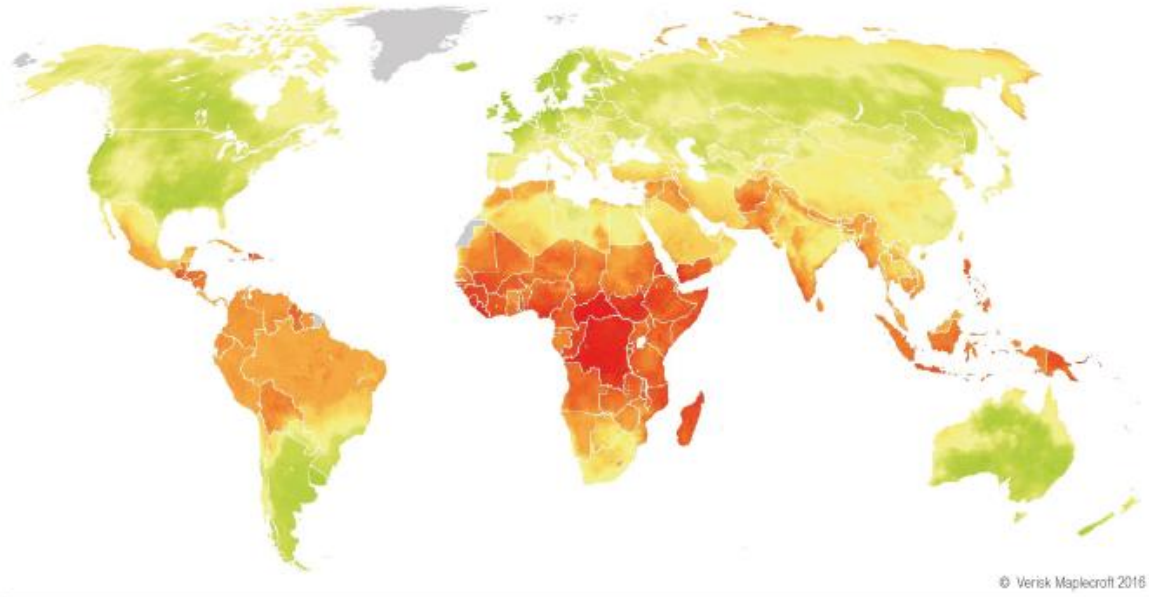
IPCC with the help of WMO and UNEP issued a Summary for Policymakers in respect of the Ocean and Cryosphere in a changing Climate. The global Ocean covers 71% of the Earth surface and contains about 97% of the Earth's water. The cryosphere refers to frozen components of the Earth system. Around 10% of the Earth land area is covered by glaciers or ice sheets.

Princeton researchers found that by the end of this century, rising oceans will almost certainly flood the lands where tens of millions of people live as accelerating Climate Change warms the waters and melt ice sheets.

Ladies & Gentlemen!

Climate Change vulnerability index 2017 shows that we lie in the high risk areas.

Climate Change Vulnerability Index 2017



The five worst performing countries

Rank	Country	Region	Score	Category
1	Central African Republic	Africa	0.01	Extreme
2	DR Congo	Africa	0.20	Extreme
3	Haiti	Caribbean	0.24	Extreme
4	Liberia	Africa	0.25	Extreme
5	South Sudan	Africa	0.41	Extreme

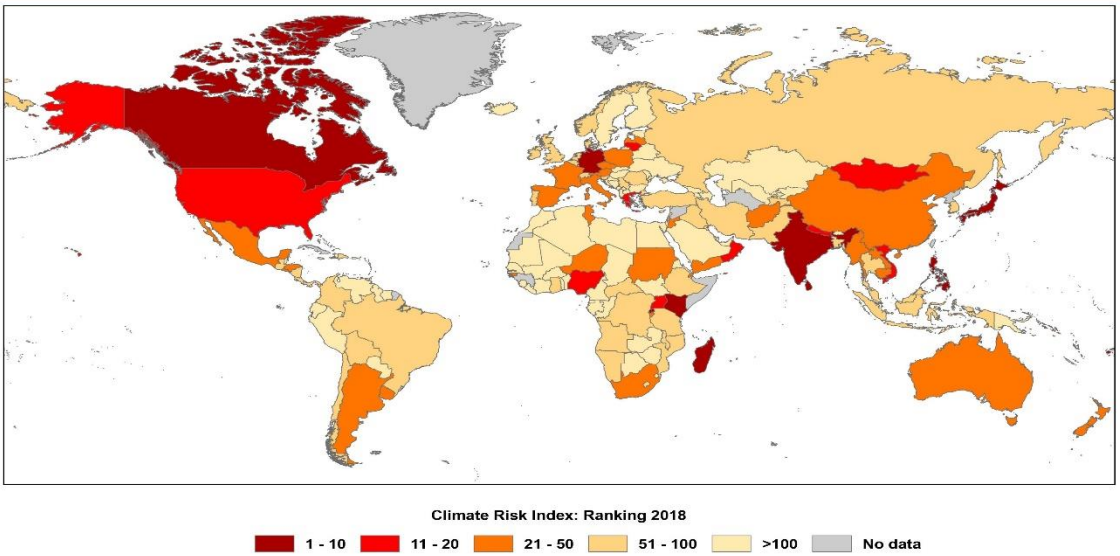
The five best performing countries

Rank	Country	Region	Score	Category
191	Denmark	Europe	10.00	Low
190	United Kingdom	Europe	9.96	Low
189	Uruguay	S.America	9.95	Low
188	Iceland	Europe	9.85	Low
187	Ireland	Europe	9.83	Low

[SLIDE 12]

Global Climate Risk Index 2020 shows that we are one of the countries most affected by extreme weather events during 1999-2018.

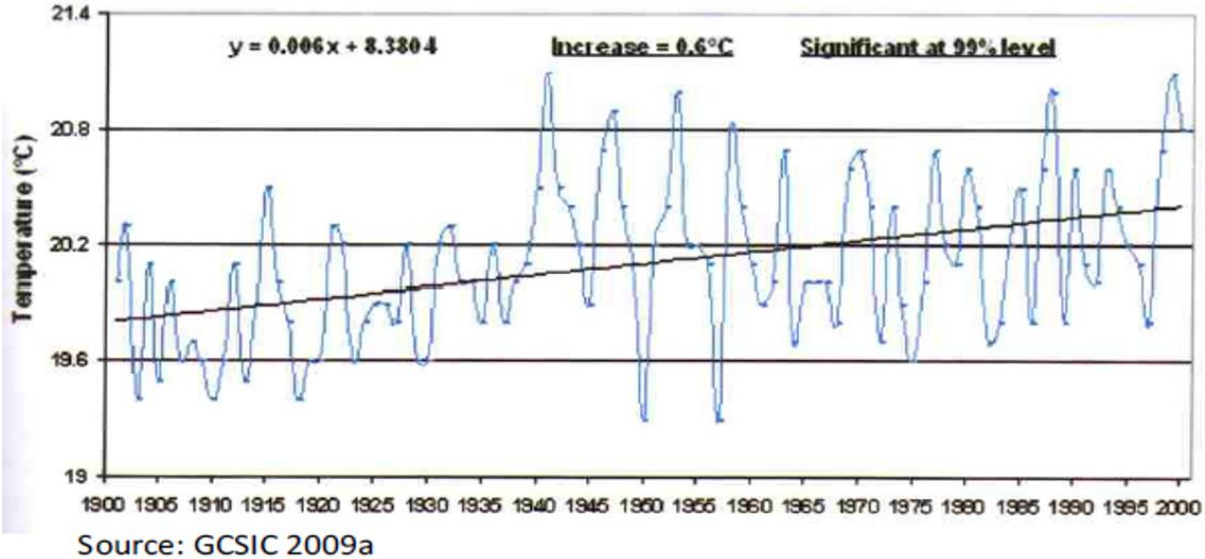
Climate Risk Index 2020



[SLIDE 13]

Global Change Impact Studies Center of Pakistan (GCSIC) recorded a temperature rise of 0.6°C over a period of 100 years since 1900

Temperature Rise

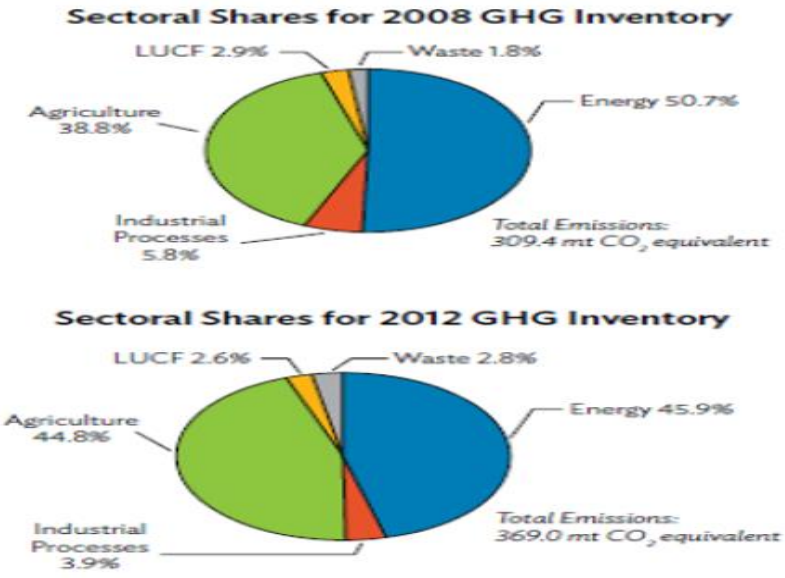


Source: GCSIC 2009a

[SLIDE 14]

Despite the fact that we have institutional and legal framework to combat Climate Change, we get factual data provided only by the international organisations. The Pakistan Environment and Climate Change Outlook (ECCO) 2013 issued by the UNEP reported concrete evidence that food, fresh water and livelihood of the Pakistanis people are under threat due to Climate Change and environment degradation. UNDP 2015 study on Climate Public Expenditure and Institutional Review (CPEIR) of Pakistan identified research gaps: "There is very limited pool of research and data available on observed changes and impacts of Climate Change on various socioecological systems and sectors at the national and subnational level". Asian Development Bank (ADB) prepared a study on Climate Change Profile of Pakistan 2017, showing:

Sector Share of Greenhouse gas Inventories for Pakistan for 2008 & 2012



CO_2 = carbon dioxide, GHG = greenhouse gas, LUCF = land use change for forestry, mt = metric ton.
Source: K. A. Mir and M. Ijaz. 2015. *Greenhouse Gas Emission Inventory of Pakistan for the Year 2011–2012*. Islamabad: Global Change Impact Studies Centre (GCISC).

[SLIDE 15]

Pakistan's Global Greenhouse Gas Emission Ranking is at 31st

Pakistan's Global Greenhouse Gas Emission

Total GHG per capita emissions = **135th**

Total GHG emissions = **31st**

GHG = greenhouse gas.
Source: The Global Economy. 2015. Country Ranking using Data on Carbon Dioxide Emissions. http://www.theglobaleconomy.com/rankings/Carbon_dioxide_emissions/ (accessed on 25 May 2015).

[SLIDE 16]

Projection of Greenhouse Emission by Sector are extremely educative. By 2020 total national emission is estimated at 650 Mt CO_2 e

Projected Greenhouse Gas Emission by Sector in 2020 and 2050 Under Business as Usual Scenarios (in $MtCO_2e$)

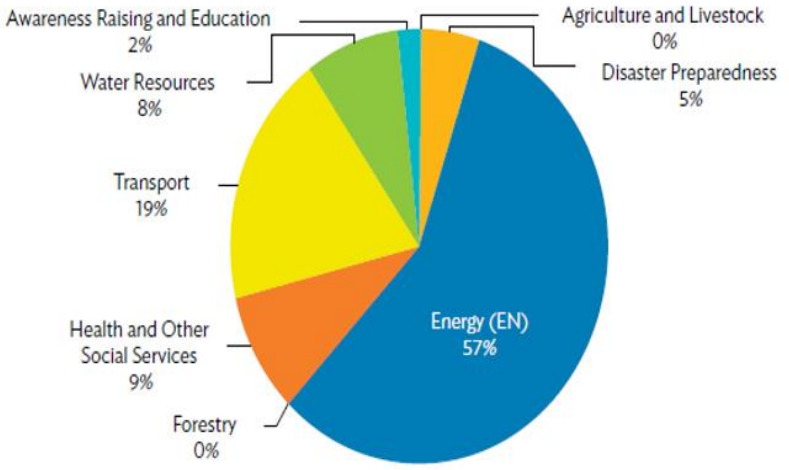
Sector	1994	2008	2012	2020	2050
Energy	86	157	169	358	2,685
Agriculture	72	120	165	245	1,395
Industrial processes	13	18	14	26	67
Land use change and forestry	7	9	10	14	38
Wastes	4	6	10	7	15
Total national emissions	182	309	369	650	4,200

GHG = greenhouse gas, $MtCO_2e$ = million ton of carbon dioxide equivalent.
Source: Government of Pakistan, Ministry of Planning, Development and Reforms. 2010. *Task Force Final Report on Climate Change*. Islamabad; K. A. Mir and M. Ijaz. 2015. *Greenhouse Gas Emission Inventory of Pakistan for the Year 2011–2012*. Islamabad: Global Change Impact Studies Centre (GCISC).

[SLIDE 17]

Sector Allocation of Expenditure to Climate Relevant Tasks shows that Energy and Transport absorbed 76% of the total allocation:

Sector Allocation of Expenditures to Climate-Relevant Tasks in the Public Sector Development Program of 2013- 2014



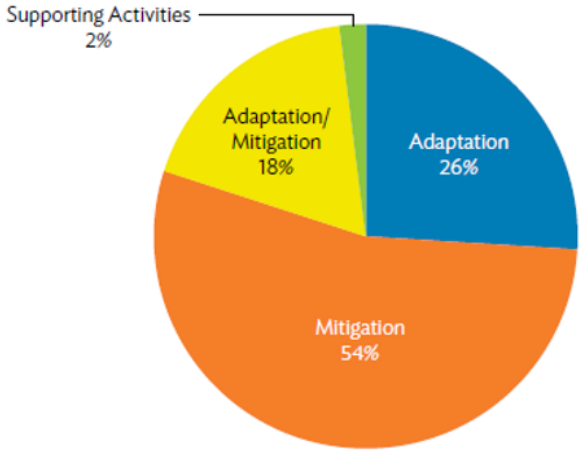
PSDP = public sector development program.

Source: United Nations Development Programme. 2015. *Climate Public Expenditure and Institutional Review (CPEIR) Study, Pakistan.* Islamabad.

[SLIDE 18]

And mitigation got 54%

Allocation of Expenditures to Climate-Relevant Activities in the Public Sector Development Program of 2013-2014



PSDP = public sector development program.

Source: United Nations Development Programme. 2015. *Climate Public Expenditure and Institutional Review (CPEIR) Study, Pakistan.* Islamabad.

[SLIDE 19]

Ladies & Gentlemen!

We have to overcome another serious impediment. United Nations Development Programme (UNDP) in its Climate Public Expenditure and Institutional Review addressed the impact of the 18th Constitutional Amendment passed in 2010.

Summary of Changes in Responsibilities Between the Federal and Provincial Levels of Government Before and After the Devolution of the 18th Constitutional Amendment in 2010

Responsibilities	Legislative Responsibilities: Changes Due to the 18th Constitutional Amendment of 2010	
	Before	After
Federal responsibility	Federal Legislative List	Revised Federal Legislative List Parts I and II. Federal Government has exclusive domain in Part 1. All policy decisions on subjects in Part II shall be decided by the Council of Common Interest.
Shared federal and provincial responsibility	Concurrent List	
Provincial responsibility	(Residual subjects not mentioned in either of the two lists)	All residual subjects not mentioned in the Federal Legislative List.

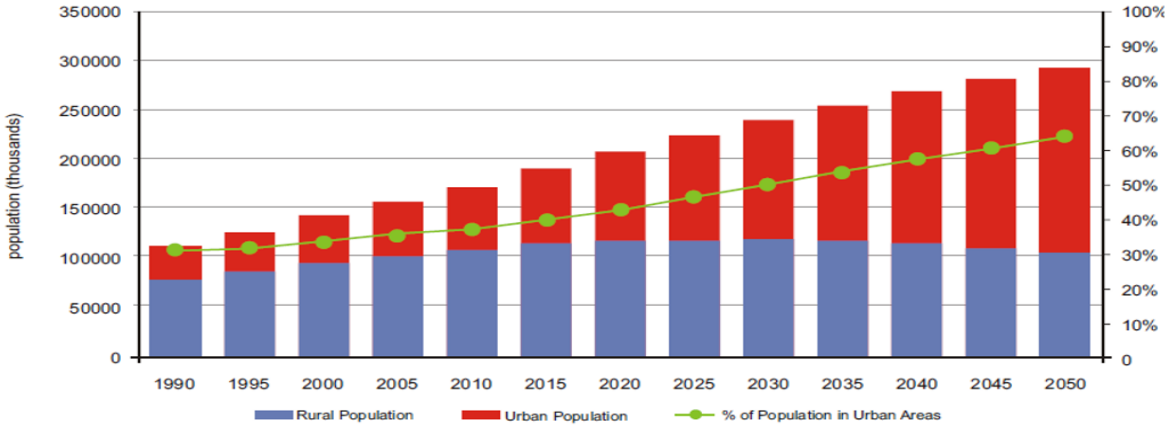
Source: United Nations Development Programme. 2015. *Climate Public Expenditure and Institutional Review (CPEIR) Study*. Islamabad.

(i) Long time frame for the impacts of climate change to unfold and be felt is a constraint to effective policy and planning formulation and implementation, while the development plans normally cover a short term of half a decade.
(ii) Cross-sector and multidisciplinary approach is required to understand the implications of climate change and respond accordingly. It requires a breadth of skills and expertise within government to address multiple dimensions of climate change.
(iii) Strong interest groups with a smaller number of losers and many dispersed winners.
(iv) National and international jurisdiction.

[SLIDE 20]

Urbanization! Another factor in respect of Climate Change. By 2050, 70% of the world population will be living in the cities. Pakistan will become the fifth largest nation on Earth by 2050 with a population of 265 million, according to the United Nations Environmental Programme (UNEP) report on "the Environment and Climate Change Outlook of Pakistan".

Pakistan: Urbanization Trends 1990-2050



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat

[SLIDE 21]

Some of Sustainable Development Goals ae patently related to Climate Change. Voluntary National Review of SDGs has been issued by the Government of Pakistan.

SUSTAINABLE DEVELOPMENT GOALS

SDG	National Base Line	2030 Targets
1	Dec 14-15	5 to 8%
2	2012-13 2014-15	38.3% 41.34%
3	2014-15	11%

[SLIDE 22]

Climate Modelling!

According to a well-illustrated article that appeared in the Economist:

- Predicting the Climate future is riddled with uncertainty.
- Building models is also hard by lack of knowledge about the ways that the Carbon- the Central atom in molecules of carbon dioxide and methane, the main heat-capturing greenhouse gases other than the water vapour-waves through the environment.
- A further problem in model building is that uncertainties about feedback loops like the one between ocean temperature and CO_2 absorption also underpin uncertainties about a parameter called **Climate Sensitivity,** which is crucial to model's prediction.

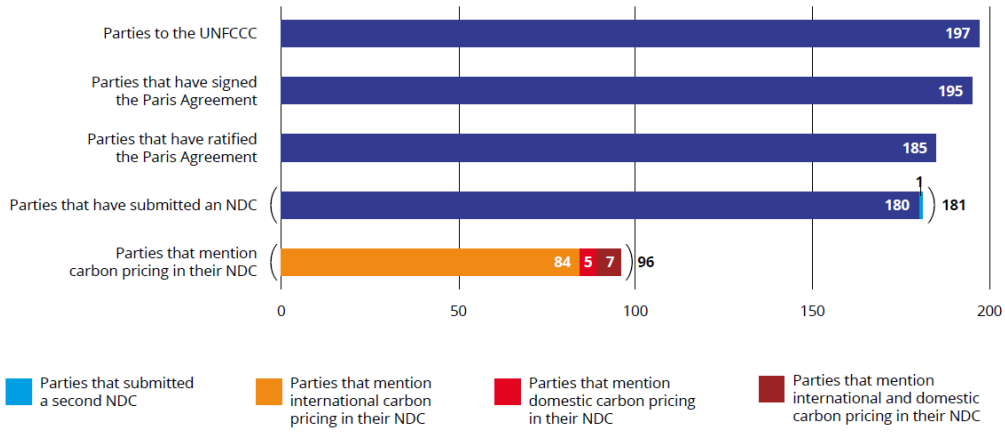
Ladies & Gentlemen!

Let us make a healthy climate a **legal right** that extends to the future generations. The Supreme Court of the Philippines affirmed that natural resources are held in trust for the benefit of present and future generations and that the government was consequently required to protect them. Pakistan's Supreme Court in 2016 allowed a case filed by a seven year old girl petitioner against the state for violating the constitutional rights of today's youth and future generations because of it's failure to combat climate change. The case is still pending.
A new domain has emerged in the context of Climate Change. It is **Climate Justice.**
Lastly I have to mention that COP_{25}, the UN Climate talks in Madrid ended in a sad splutter on December 15, 2019. There was no agreement on international carbon markets; only weak commitments to more drastic cuts in emissions.

I fervently hope that you will enjoy the presentations made by our valuable speakers

Thank you.

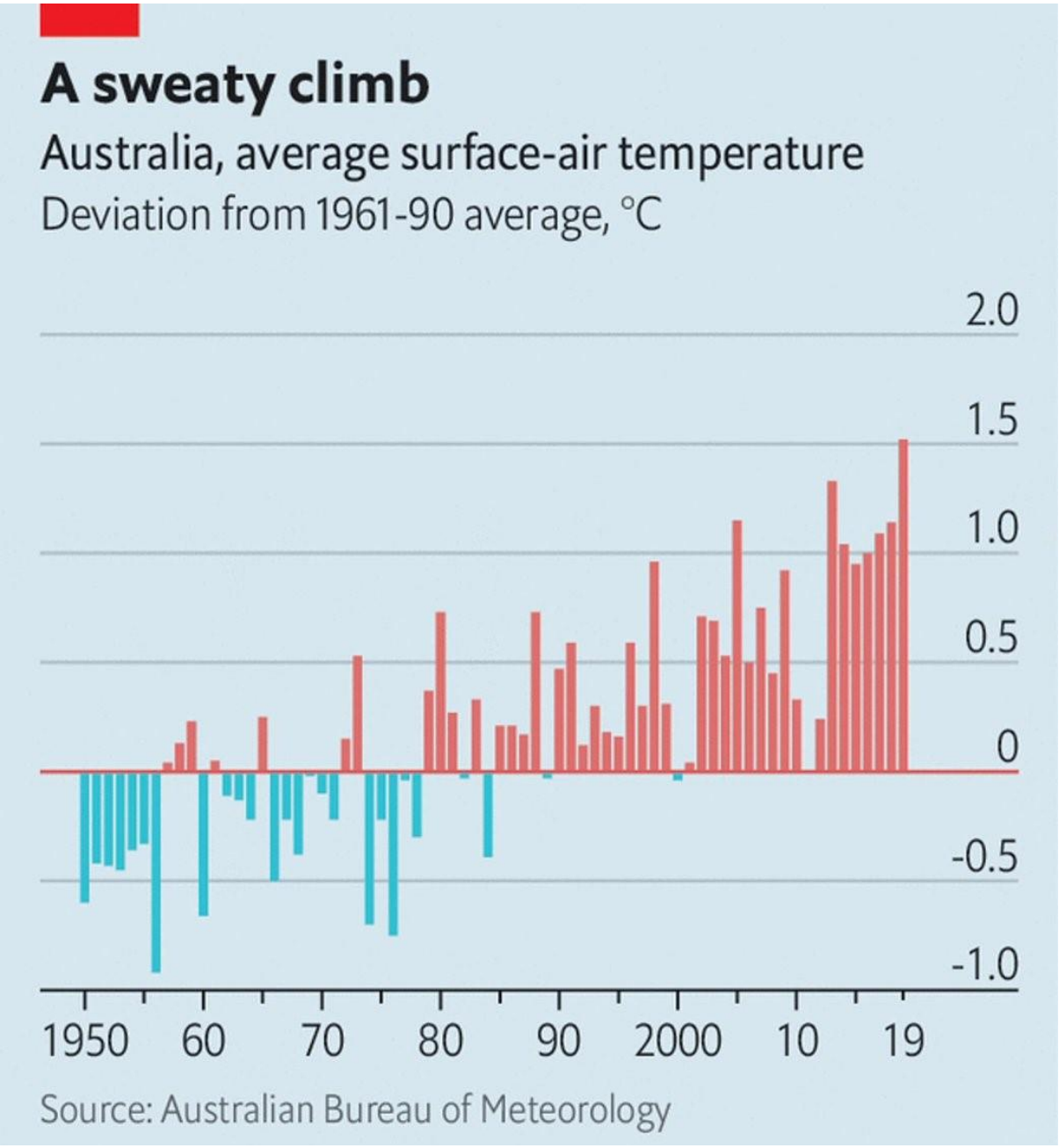
Status of NDC submissions



[Slide 23]

NDCs	Unconditional target	Conditional target	Mention of carbon pricing
Micronesia, Federated States of	Unconditional reduction of 28% below 2000 levels by 2025	Additional 7% is conditional	No
Moldova	64-67% reduction below 1990 levels by 2030	Additional 11-14% is conditional	International
Monaco	50% below 1990 levels by 2030	——	International
Mongolia	——	14% below BAU by 2030	International
Montenegro	30% below 1990 levels by 2030	——	International
Morocco	17 % reduction by 2030 compared to BAU, with 4% coming from AFOLU actions. Without AFOLU actions, the reduction target is 13%.	Additional 25% reduction (21% without AFOLU) is conditional	International
Mozambique	——	Reduction of 76.5 $MTCO_2e$ by 2030	International
Myanmar	NDC sets out a number of sectoral measures	——	No
Namibia	79% reduction compared to BAU levels by 2030	Additional 10% is conditional	International
Nauru	NDC sets out a number of measures in the energy sector	——	No
Nepal	——	NDC sets out sectoral targets	International
New Zealand	30% below 2005 levels by 2030	——	International
Nicaragua	Continue the increase of renewables to 60% by 2030 Maintaining the countries' carbon sink at current levels	Increase the national carbon sink by 20% compared to the business-as-usual scenario by 2030	International
Niger	Unconditional target of 2.5% below 2020 BAU levels by 2020 and 3.5% below 2030 levels by 2030	Additional 22.5 by 2020 and 31.1% by 2030 is conditional	International
Nigeria	20% unconditional reduction below BAU by 2030	Additional 25% is conditional	International
Niue	NDC sets out a number of measures in the energy sector	——	No
North Macedonia	30% reduction of CO_2 emissions from fossil fuel combustion below BAU by 2030	Additional 6% is conditional on higher level of ambition	International
Norway	At least 40% below 1990 levels by 2030	——	Domestic
Oman	——	2% below BAU by 2030	
Pakistan	NDC does not set out any specific target	——	No
Palau	22% energy sector emissions reductions below 2005 levels by 2025	——	No
Panama	10% increase of absorption capacity of forests by 2050 compared to 2015	Additional 70% absorption capacity is conditional	International and domestic

[Slide 24]


A sweaty climb
Australia, average surface-air temperature
Deviation from 1961-90 average, °C
2.0
1.5
1.0
0.5
0
-0.5
-1.0
1950
60
70
80
90
2000
10
19
Source: Australian Bureau of Meteorology

[Slide 25]