Innovative Solutions for Climate Change Management –

Sharing of experience on Green Energy initiatives at DTU, RGTU and Amity

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Prof. PB Sharma, 16th November, 2016 at Climate Research Institute, New Delhi

Energy Reserves

Coal

- ✓Global coal reserve estimated 8,26,001 million tonnes by end of 2008
- ✓USA largest share of the global reserve - (28.85%)
- ✓Russia (19.0%), China (13.86%)
- ✓India is 4th in the list with 7.09%

Oil

- ✓Global proven oil reserve estimated 1268.0 billion barrels by the end of 2008
- ✓Saudi Arabia largest share of the reserve - 21.0%
- ✓India had only 0.5% share of the world reserve

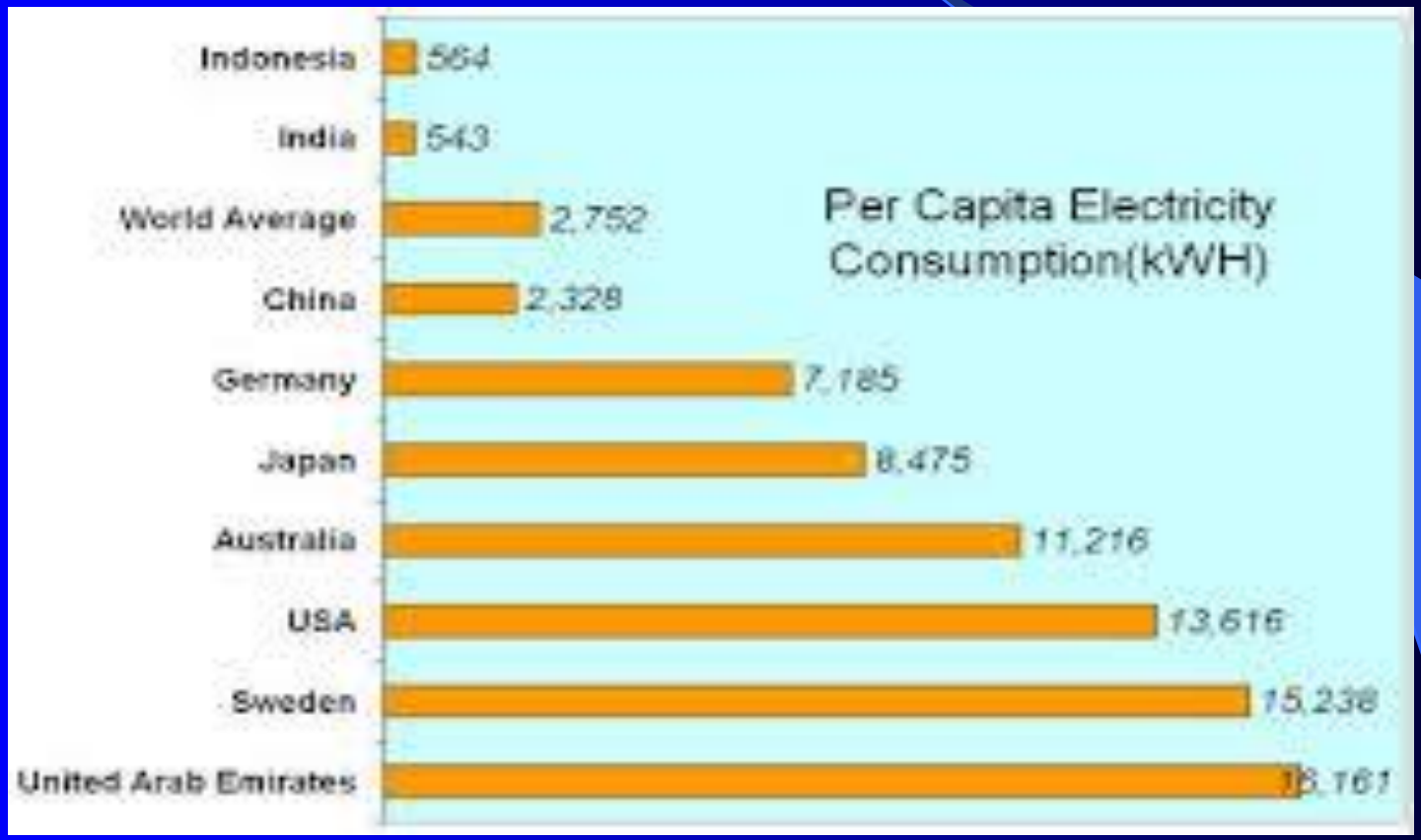
Gas

- ✓Global proven gas reserve estimated 185.2 trillion cubic meters by the end of 2008
- ✓Russian Federation largest share of the reserve - 23.4%
- ✓India had only 0.6% share of the world reserve

Primary Energy Consumption by Fuel , 2008

In million tonnes oil equivalent (mtoe)						
Country	Oil	Natural Gas	Coal	Nuclear Energy	Hydro electric	Total
USA	884.5	600.7	565.0	192.0	56.7	2299.0
Canada	102.0	90.0	33.0	21.1	83.8	329.8
France	92.2	39.2	11.9	99.6	14.3	257.9
Russian Federation	130.4	378.2	101.3	36.9	37.8	684.6
United Kingdom	78.7	84.5	35.4	11.8	1.1	211.6
China	375.7	72.6	1406.3	15.5	132.4	2002.5
India	**135.0**	**37.0**	**231.4**	**3.5**	**28.2**	**433.3**
South Korea	**103.3**	**35.7**	**66.1**	**34.2**	**0.9**	**240.8**
Japan	221.8	84.4	128.7	57.0	15.7	507.5
Malaysia	21.8	27.6	5.0	-	1.5	56.0
Singapore	49.9	8.3	-	-	-	58.2
TOTAL WORLD	**3927.9**	**2726.1**	**3300.7**	**619.7**	**717.5**	**11294.9**

Per Capita Energy, Electricity Consumption



Indian Petroleum Scenario

Year	Domestic Production, (Mt)	Demand, (Mt)	Self Reliance, (%)
1990-91	33.02	53.72	61.4
1995-96	35.17	62.51	56.2
2000-01	32.43	106.523	30.4
2001-02	32.03	110.738	28.92
2003-04	33.38	123.815	26.96
2004-05	33.98	129.84	26.17
2006-07	33.99	144.85	23.46
2013-14	38.11	160.78	21.89

Import - 122.67 million tones

CLIMATE CHANGE – A GLOBAL CONCERN

- Energy is essential for development of a country.
- India, one of the largest economy of the world requires ever-increasing use of energy to sustain growth.
- Energy Security and mounting challenge of climate change impact the economies of the nations the world over.
- Abrupt climate change – A serious threat for food and water security, also a threat to the economy.

We need to focus on both the development and deployment of Green and Clean Energy Technologies to arrest Climate Change.

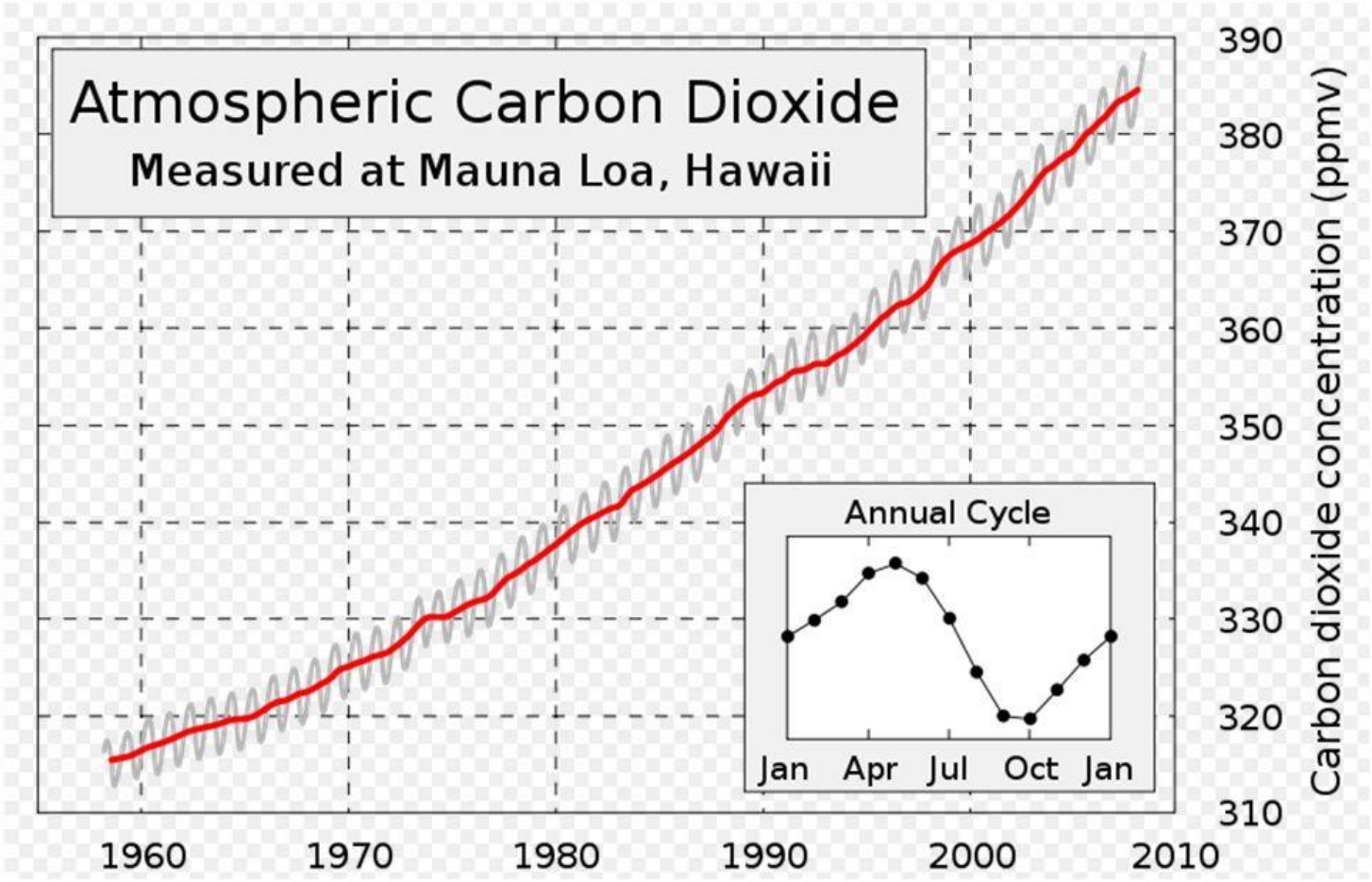
REASONS for CLIMATE CHANGE

- Persistent manmade changes in the composition of the atmosphere or in land use.
- Greenhouse gases like CO_2, Methane, Ozone are also important in understanding Earth's climate history.
- Warming produced as greenhouse gases trap heat, plays a key role in regulating Earth's temperature.

Nexus between Pollution and Climate Change

- Air Pollution - A major cause of death, cardiovascular disease and asthma.
- Air Pollution related mortality increases as the climate warms further.
- Increased use of industrial activity without systems for affluent treatment makes life miserable.
- Up gradation of technology and innovative solutions provide a major gateway to arrest climate change.

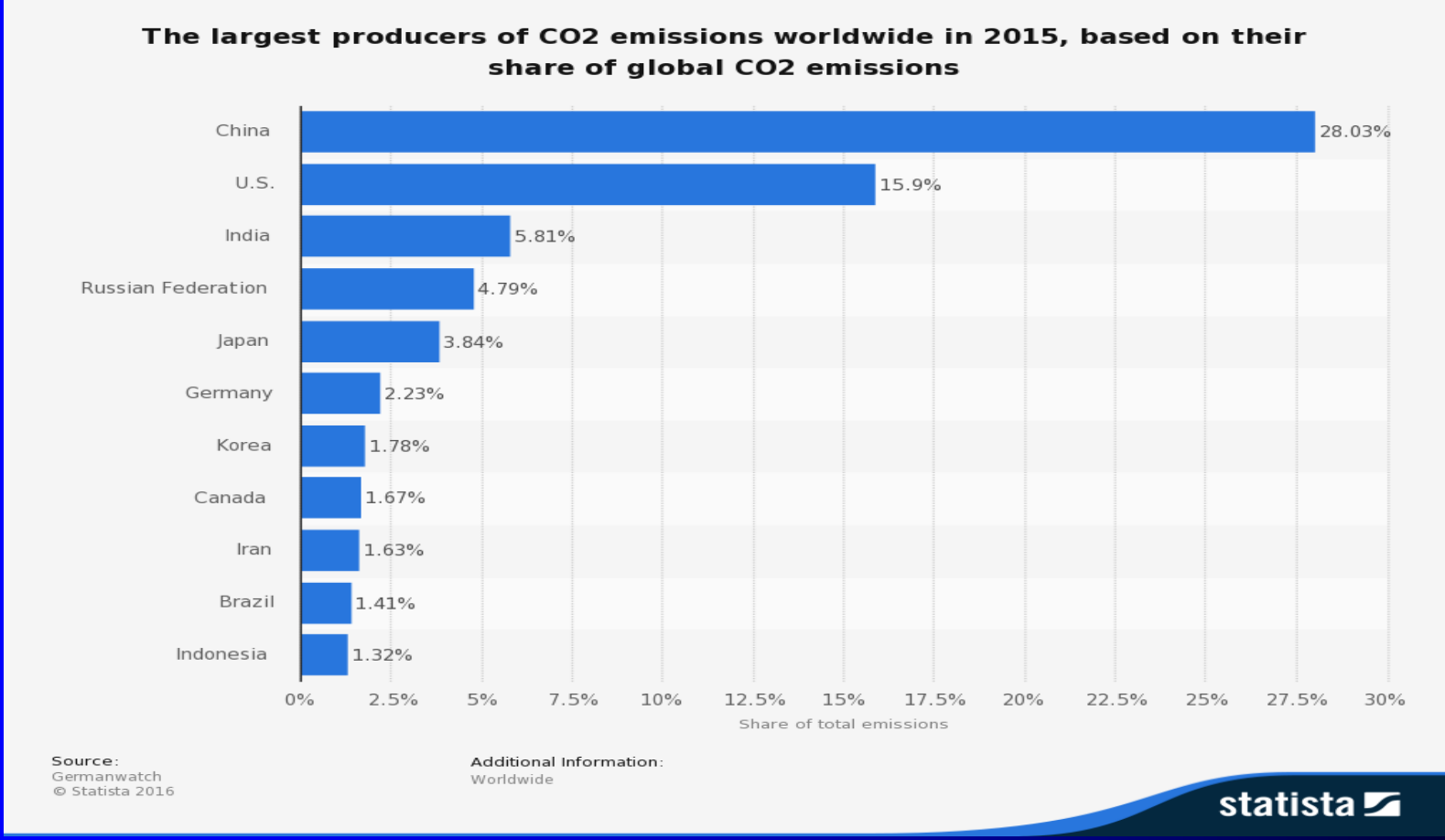
GLOBAL CO_2 EMISSIONS – A GLOBAL CONCERN



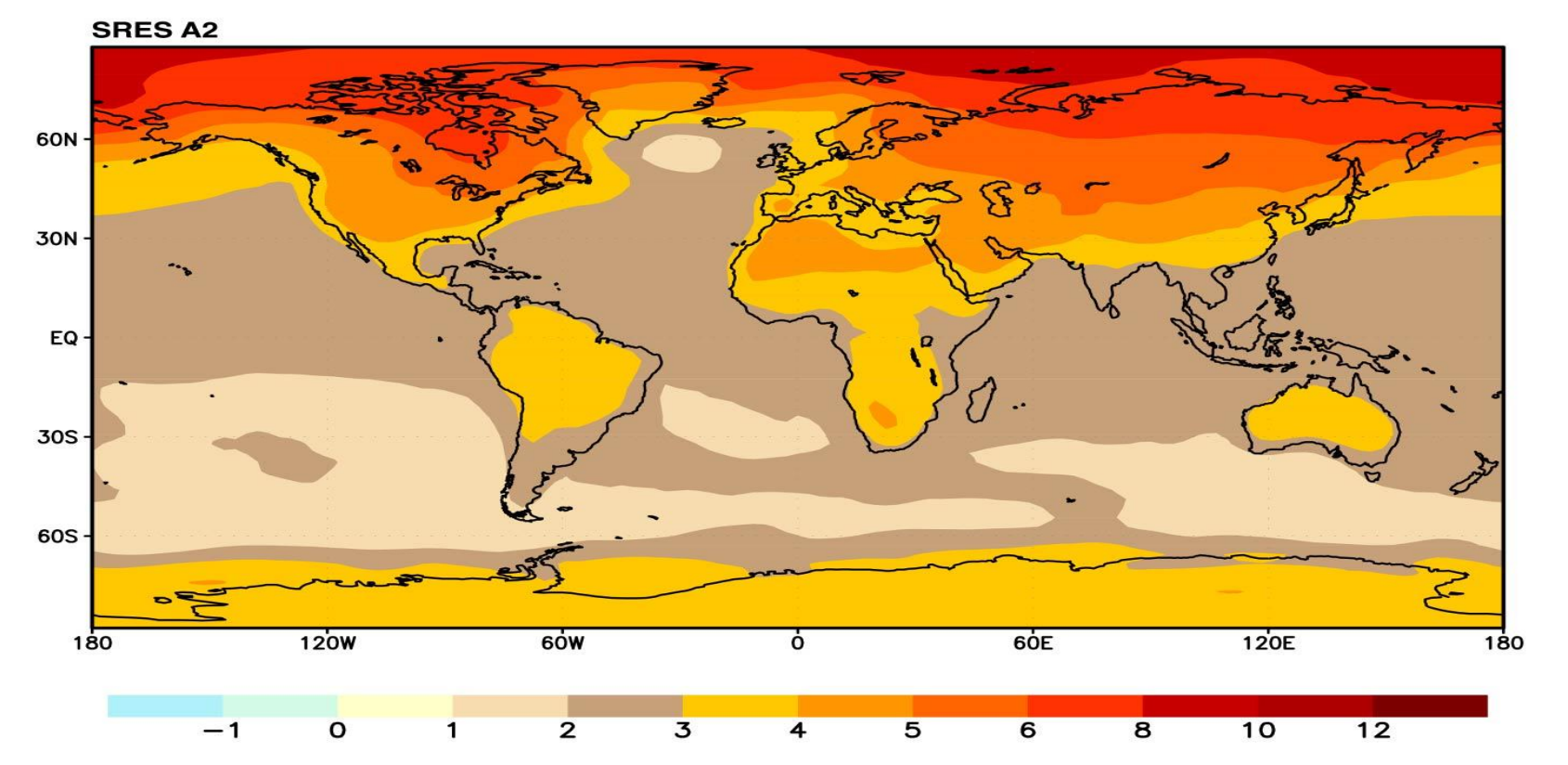
CO_2 Concentration in last 50 years

Source : NOAA Mauna Loa Observatory

Major CO_2 Producing Countries



Land areas are projected to warm more than the oceans with the greatest warming at high latitudes



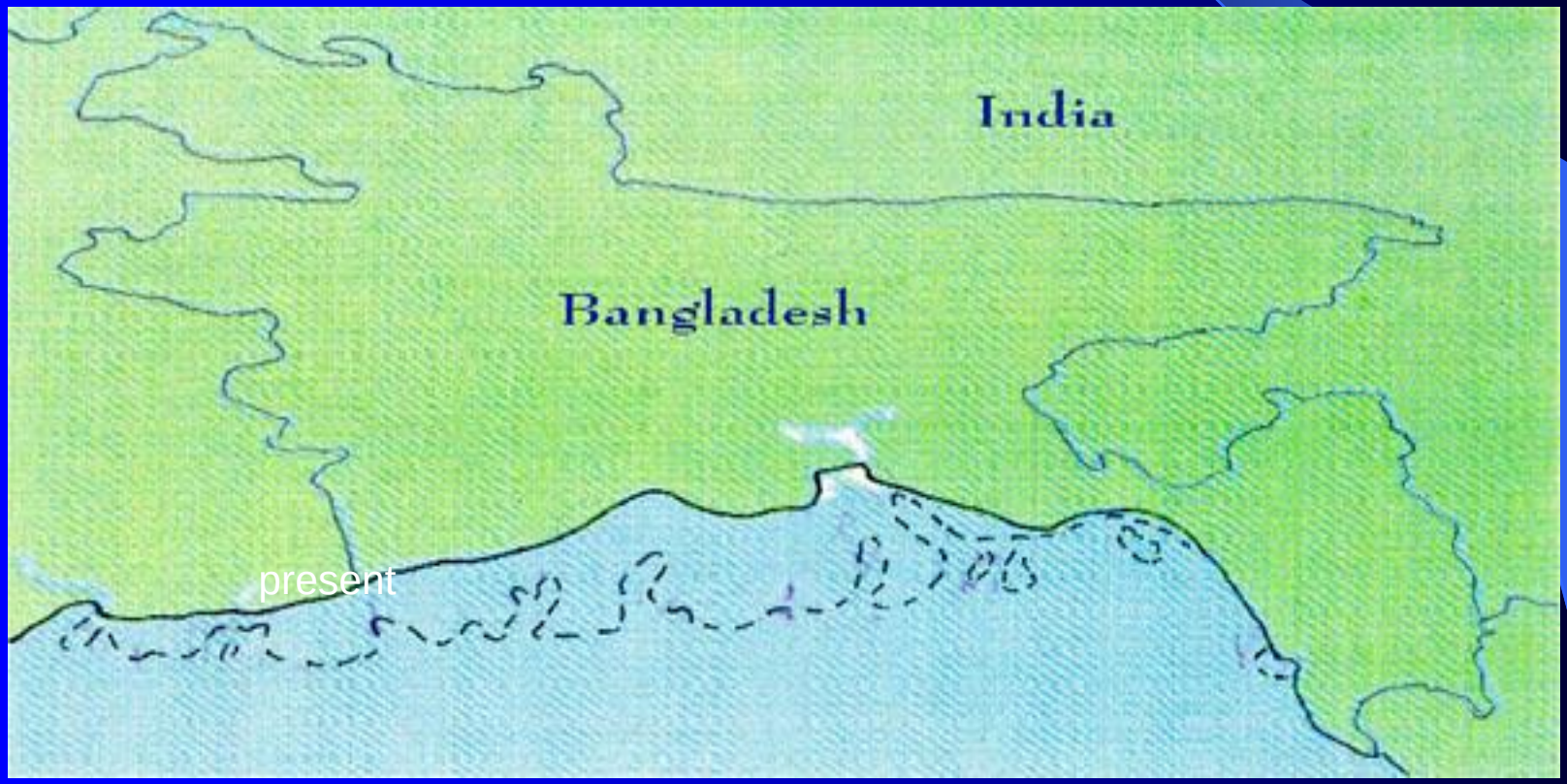
Annual mean temperature change, 2071 to 2100 relative to 1990:

Global Average in 2085 = 3.1°C

Source : IPCC 2001

IMPACT OF CLIMATE CHANGE

Increased risk of floods, potentially displacing tens of millions of people, due to sea level rise and heavy rainfall events, especially in Small Island States and low-lying deltaic areas. Bangladesh is projected to lose about 17% of its land area with a sea level rise of one meter - very difficult to adapt due to lack of adaptive capacity



Climate change is projected to decrease water availability in many arid- and semi-arid regions

One third of the world's population is now subject to water scarcity

Population facing water scarcity will more than double over the next 30 years

Biodiversity underlies all ecological goods and services

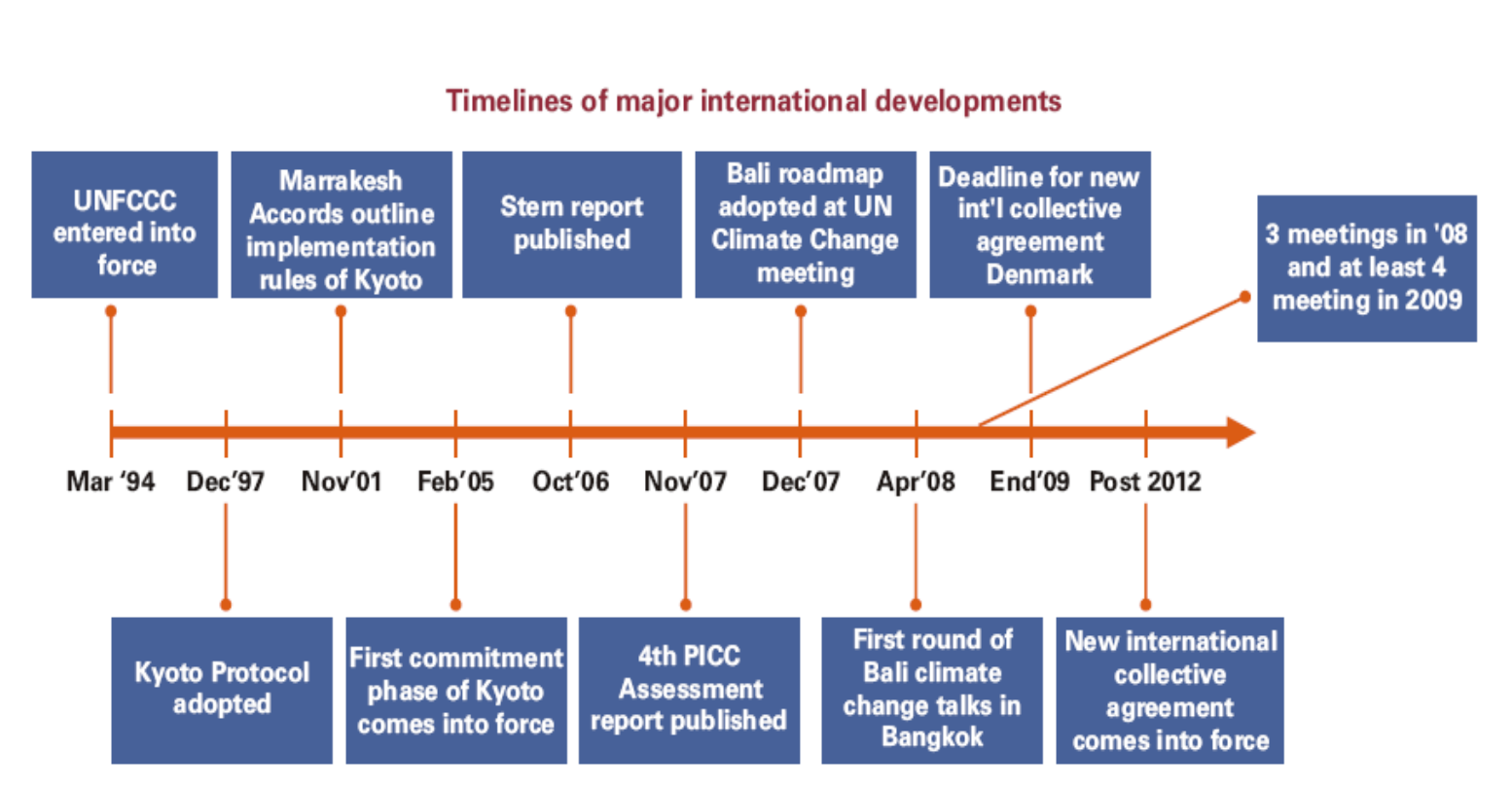
Estimated 10-15% of the world's species could become extinct over the next 30 years

Climate change will exacerbate the loss of biodiversity

Developing countries are the most vulnerable to climate change

- Impacts are worse - already more flood and drought prone and a large share of the economy is in climate sensitive sectors.
- Lower capacity to adapt because of a lack of financial, institutional and technological capacity and low public awareness.
- Climate change is likely to impact disproportionately upon the poorest countries and the poorest persons within countries, increasing inequities in health status and access to adequate food, clean water and other resources.

Global Initiatives to tackle Climate Change



In G-8 summit in Japan, India supported the call from the 5 outreach countries for developed countries to cut their emissions by 25-40 per cent by 2020 and more than 80 per cent by 2050 (below 1990 baselines).

India's Action Plan on Climate Change

- India's first ever action plan on climate change is expected to serve as a valuable negotiating tool in international discussions.
- India's action plan will also work as a nodal framework to bring together India's efforts in mitigation and adaptation amounting to 2.6 percent of GDP in 2006-07.
- The Plan focuses on efficiency targets rather than quantitative emission targets.

India's 8 Missions on Climate Change Management

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Ecosystem
- National Mission for a "Green India"
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change

Focus of Action Plan

- National Mission for Enhanced Energy – Goals
  - Mandating specific energy consumption decreases in large energy-consuming industries, with a system for companies to trade energy-savings certificates.
  - Energy incentives, including reduced taxes on energy-efficient appliances.
  - Financing for public-private partnerships to reduce energy consumption through demand-side management programs in the municipal, buildings and agricultural sectors.

Focus of Action Plan

- National Mission on Sustainable Habitat – Goals
  - Extending the existing Energy Conservation Building Code.
  - A greater emphasis on urban waste management and recycling, including power production from waste.
  - Strengthening the enforcement of automotive fuel economy standards and using pricing measures to encourage the purchase of efficient vehicles.
  - Incentives for the use of public transportation.

Innovative Measures to Tackle Climate Change

- Technologies for CO_2 absorption and conversion to multi-fuel like H_2, Bio-diesel and Methanol.
- Shift from Carbon based Energy and transportation to H2 Based systems.
- Increased use of Bio-fuels, Biomass gasification and alternatives- compressed Air, Liquid Nitrogen for transportation.
- Increased use of Electric Vehicles, Hybrid Vehicles, H_2 Cars, H_2 Trains and innovative measures like electricity from moving vehicle and moving trains, shall offer opportunities for GHG mitigation.

DTU GREENTECH INITIATIVES

- Successfully completed "**Development of an efficient biodiesel reactor for rural application and utilization of multi feedstock derived biodiesel in medium capacity diesel engine**" Ministry of New and Renewable Energy, GOI.
- PCRA Sponsored project "**Development & process optimization of a medium capacity state of art biodiesel processing unit**" completed successfully.
- Yanmar Co. Ltd., Osaka, Japan funded project Performance & Endurance Tests on a Yanmar 10 KW diesel Generator set fuelled with neat biodiesel (B100)" started on December 4, 2007. The trial has recently reached to 5,500 hours mark.

Biodiesel Research @DTU

Feed Stock – Jatropha, Karanja, Thumba, Rice Brand oil, Used Cooking oil, Mahua and Castor oil.

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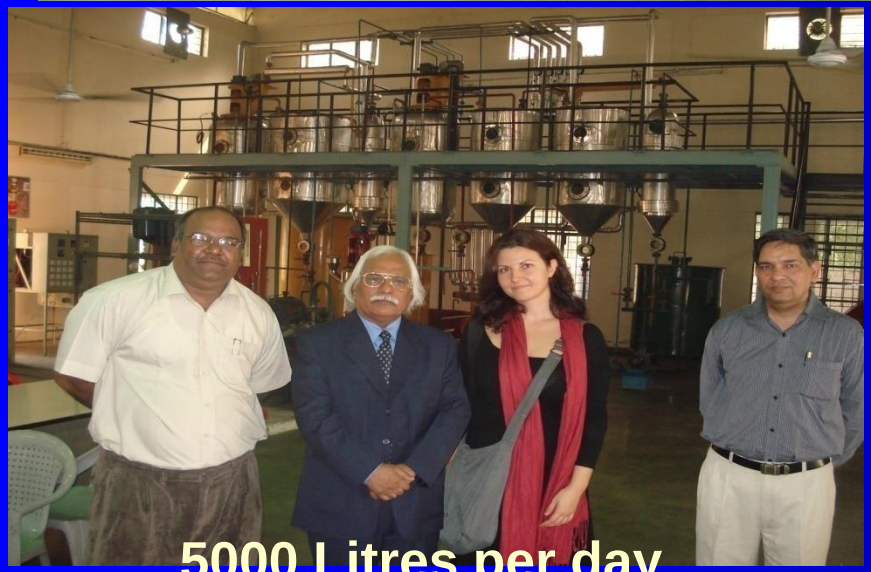
Energy Farming at DTU

Biodiesel Reactors Developed at DTU

600 Litres per day

10 Litres per batch



5000 Litres per day

10,000 HrsTest Run on Biodiesel for Yanmar, Japan

DTU GREENTECH INITIATIVES

- Provided Consultancy in World Bank Funded project **"Fences for Fuel"**. Project includes setting up Jatropha cultivation at the fences of the field of farmers of Viratnagar Block of Jaipur District and setting up bio-oil extraction facility, biodiesel production facility and decentralized power generation facility.

DCE Unmanned Vehicle wins

"The Most Innovative Design Award"
at International Aerial Robotics Competition, Georgia USA

2006

AUVSI
ASSOCIATION FOR UNMANNED VEHICLE SYSTEMS INTERNATIONAL

Most Innovative Design
International Aerial Robotics Competition

ASSOCIATION FOR UNMANNED VEHICLE SYSTEMS INTERNATIONAL

AERIAL ROBOTICS COMPETITION

World-Class Engineering Challenge

AUVS-*Atlanta*

Judging Officials

Kenneth R. Thurman

DCE Hybrid Car Team with Hon'ble Chief Minister Smt. Sheila Dikshit

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DCE Super Mileage Vehicle

Won the Best Design Award & Best Team Award at World Competition held at Michigan, US, June 10, 2005

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DTU Solar Car for World Solar Challenge, Australia 2011

MoU With DMRC

19h March, 2013

- **Joint Research and Development**
- **Joint Consultancy Projects**
- **Indigenization of Metro Technology**
- **Training and Skill Development**
- **Student Internship & Metro Ph.D Fellowships**

DTU UAS – Aarush XI

DTU UAS – Aarush XI (next General UAV designed and developed by DTU Student Team with support of Lockheed Martin) – has been unveiled on November 2nd, 2012 by Padma Shri Dr. V.K. Saraswat, Director General, DRDO and Scientific Advisor to Raksha Mantri in presence of Shri R.P. Agrawal, Chairman, BoM, DTU.

Hon'ble President of India Flagged off DTU Solar Passenger Car from Rasatrapati Bhawan on 4th September, 2012

DTU Solar Passenger Car is participating in the South African World Solar Challenge 2012 from September 15 – October 1, 2012

Energy From Kitchen Waste

- 500Kg/day Kitchen Waste to Gas plant was established at DTU .
- The Gas produced was utilized for cooking in DTU Canteen.
- The residue was further utilised as organic fertiliser for the DTU Nursery.

RGTU GREENTECH INITIATIVES

- ***Energy Farming and Bio diesel production in RGTU Campus***.
  - About six thousand Jatropha plants have been planted in the wide spread campus of RGTU and a Jatropha nursery has also been established for research in high yield variety development.

- ***Renewable energy devices developed at RGTU***.
  - RGTU has established a Green Energy Technology Park in its campus.
  - Power generation through Wind – Solar Hybrid system and Bio-mass Gasifier of integrated capacity of 12 kW.

RGTU GREENTECH INITIATIVES

RGTU Solar Wind Hybrid.

BIOMASS Gasification Unit

RGTU recognizing national need to support the National Mission on Bio Fuels and to significantly augment the country's efforts to mitigate the adverse effects of climate change, has taken up a number of initiatives to strengthen technology innovations in the area of Green Energy Technologies.

RGTU GREENTECH INITIATIVES

- Design and Development of Energy Efficient Bio diesel Reactors based on trans-esterification.
- R&D for bio-diesel production from non edible oils through bio-enzymes.
- Bio mass gasification for rural energy needs.
- Promotion of Bio Diesel and Bio Mass entrepreneurship for rural prosperity.
- R&D on Solar Wind Hybrid for decentralized power generation.
- CO_2 sequestration technologies for CO_2 capture and for India's compliance of CDM.

RGTU GREENTECH INITIATIVES

Biomass Gasification

- 10 kW Biomass Gasifier at RGTU Campus.
- Biomass requirement met from the campus itself.
- Hybrid system combining solar, wind and biomass developed for energy centre lighting.

RGTU GREENTECH INITIATIVES

- ***72 kW Wind-Solar Hybrid for campus lighting at RGTU*.**
  - A 72 kW Wind-Solar Hybrid system comprising of five wind turbines of 12 kW each integrated with 12 kW of solar panels will form the wind solar farm at RGTU, Bhopal
  - These together with solar shall meet the requirement of street lighting, boys and girls hostel, administrative block and a few academic blocks, thus making RGTU a Green Energy Campus.

CO_2 SEQUESTRATION & PRODUCTION OF MULTIPURPOSE FUEL

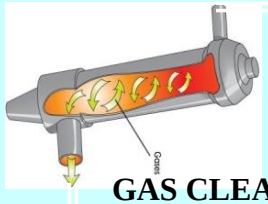
STEAM

STEAM INJECTION

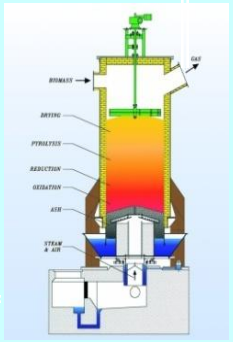
H2 FUEL CELL

WATER

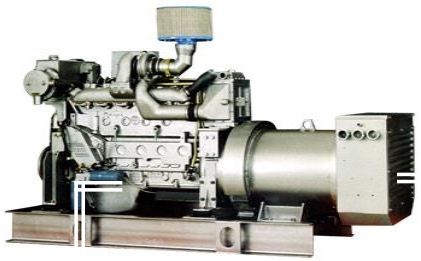
MAINLY CO



GAS CLEANING

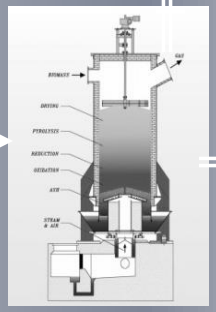


CARBON SHIFT
$CO+H_2O=CO_2+H_2$



GAS GENERATOR

BIOMASS GASIFIER



CH_4

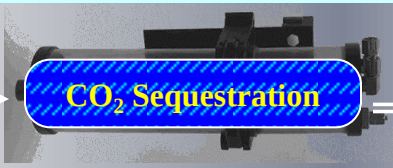
METHANE

HYDRO GASIFIER

$CO+3H_2=CH_4+H_2O$

CHAR
COAL

Mainly
CO_2

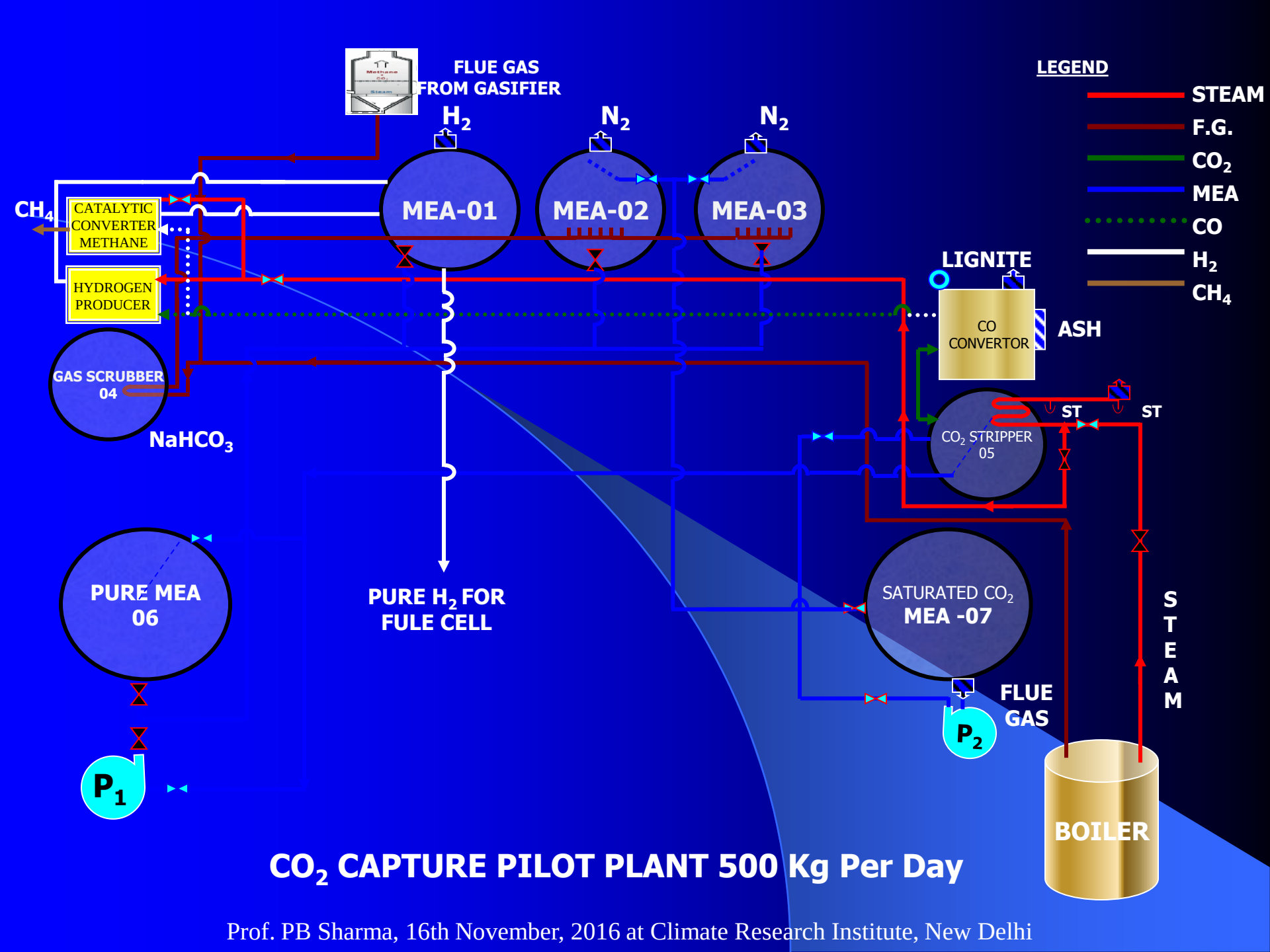


FLUE GASES
FROM
ENGINGE

CATALYTIC FLASH
$CO_2+C=2CO$
REDUCTION

ALGAE
POND

BIODIESEL PRODUCTION
FROM ALGAE



CO_2 CAPTURE PILOT PLANT 500 Kg Per Day

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CO_2 ABSORPTION AND Conversion into H_2, Biodiesel and Methanol at RGTU

Amity University Gurgaon- Solar Car-2014

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Amity University Gurgaon-Solar Hybrid Vehicle-2014

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Amity University Gurgaon Gyroscopically Controlled Aircraft,

Patent No 3221/DEL/2014, Pavleen Bali et al.

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Amity University Gurgaon- Student Innovative Project-2015
3D Printing Machine

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Amity University Gurgaon- Student Innovative Project-2015

Thermo Electric Quad Bike

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Amity University Gurgaon

Green Tech Vehicles escorting Founder President Amity University at National Innovation Conclave

On 5th October 2015

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Amity University Gurgaon- Student Innovative Project-2015
Autonomous Underwater Vehicle: Amity Robotic Submarine

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Amity University Gurgaon

Production of Bio-Diesel from Jatropha Plants

“Renewable Source of Energy ”

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Battery Operated Rickshaw and Car in India

The world's first hydrogen-powered passenger train is coming to Germany in December 2017

- The Hydrogen train is powered by fuel cell and utilizes regenerative breaking energy.

Hydrogen Fuel Cell Car

Honda, Toyota, Ford, BMW. Why not Maruti

Prof. PB Sharma, 16th November,
2016 at Climate Research Institute,
New Delhi

CONCLUSIONS

- India is a large rapidly developing country with nearly two-thirds of the population depending directly on the climate sensitive sectors such as agriculture, fisheries and forests.
- The projected climate change is likely to have implications on food production, water supply, biodiversity and livelihoods.
- The innovative initiatives of the kind taken at DTU, Amity and RGTU are required to strengthen India's Mission on Climate Change.

CONCLUSIONS

- Biofuels offer a highly viable solution to the problem of reducing dependence on crude oil and mitigate exhaust emissions in the transport sector.
- Solar, wind biomass hybrid offers a highly useful programme for rural electrification.
- Battery operated Cars, Hybrid Cars, Hydrogen Cars and Hydrogen Trains are the solutions for Climate Change.
- Innovative solutions like CO_2 sequestration and its conversion into Hydrogen, Bio-diesel and Methane from a single plant offers a high hope for arresting Climate Change.
- Industry academia partnership in such innovative initiatives is the need of the hour.

Concluding Remarks

- Why should India not aim at 40% Cars and 100% Autos on battery (Electric) by 2020 ?
- With Solar Mission aiming at 100,000 MW Solar Photovoltaic by 2020, Why should we satisfy with Solar Cells of 18% efficiency ?
- Why not Indian Scientists develop Solar Cell of 98% efficiency ?.
- Innovative solutions are the need of the hour.

THANK YOU
for Your Precious Time

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