

# IEEE Mangalore Webinar (June 2020)

Topic :

“Technologies For Sustainable Environment,  
Kickstarter Projects to Start Small and Grow”

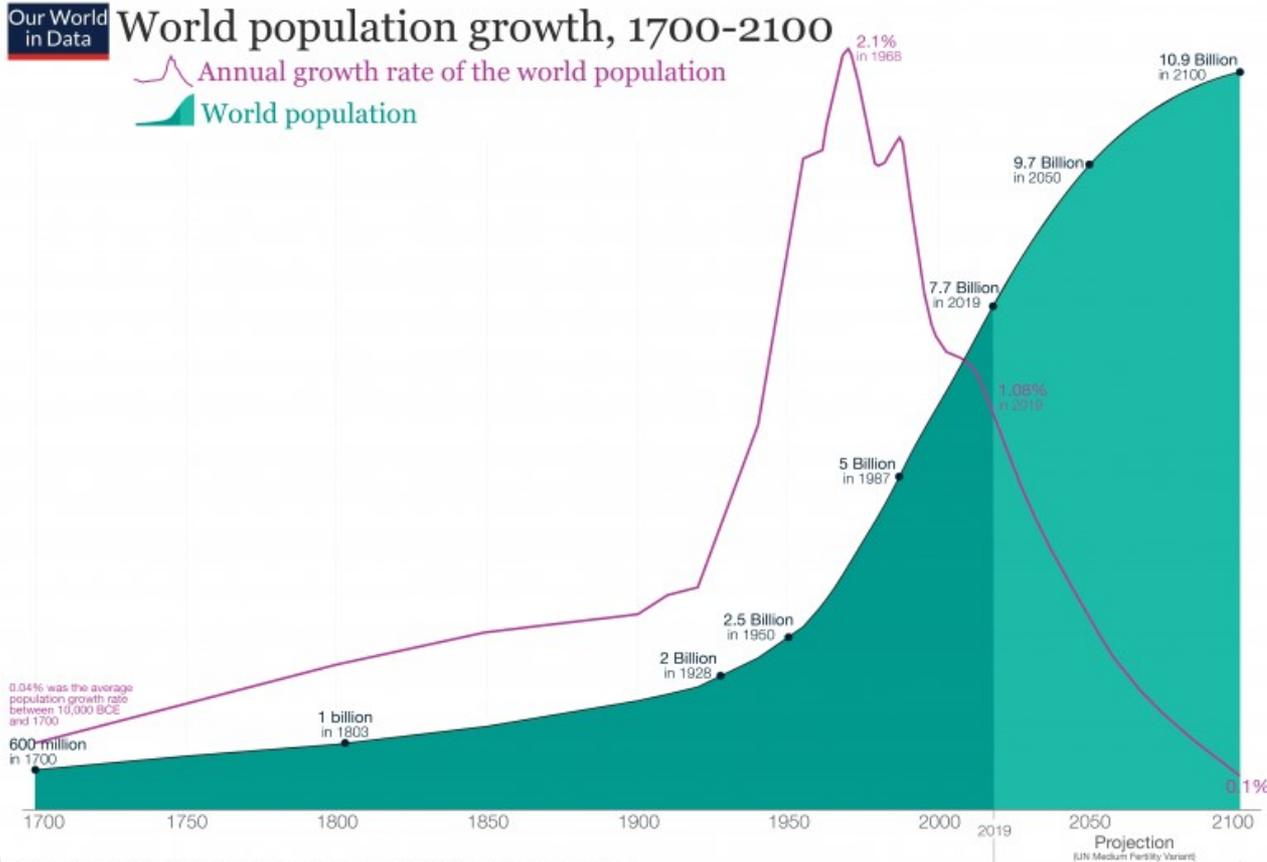
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*Credits: Public Images from the Internet courtesy various sources :NOAA, climatechange.org, FAO, researchgate, creativecommons.org, climateralityproject.org, IRENA, IBERDROLA, National Geophysical Research Institute, Bioenergyconsult.com, Suzuki, sunmobility*

# Why is there Environmental Degradation Root Cause .... Its Us ☹️



Data sources: Our World in Data based on HYDE, UN, and UN Population Division [2019 Revision]  
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.

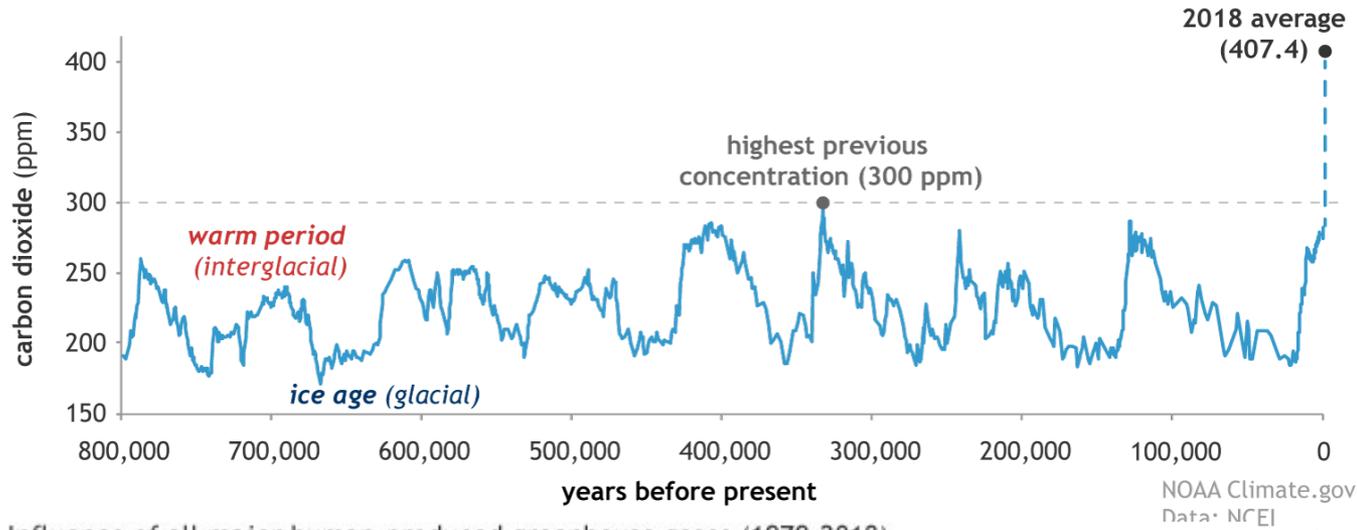
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Humans need  
Food, Water,  
Energy and  
Space/Shelter  
for an ever  
growing  
population

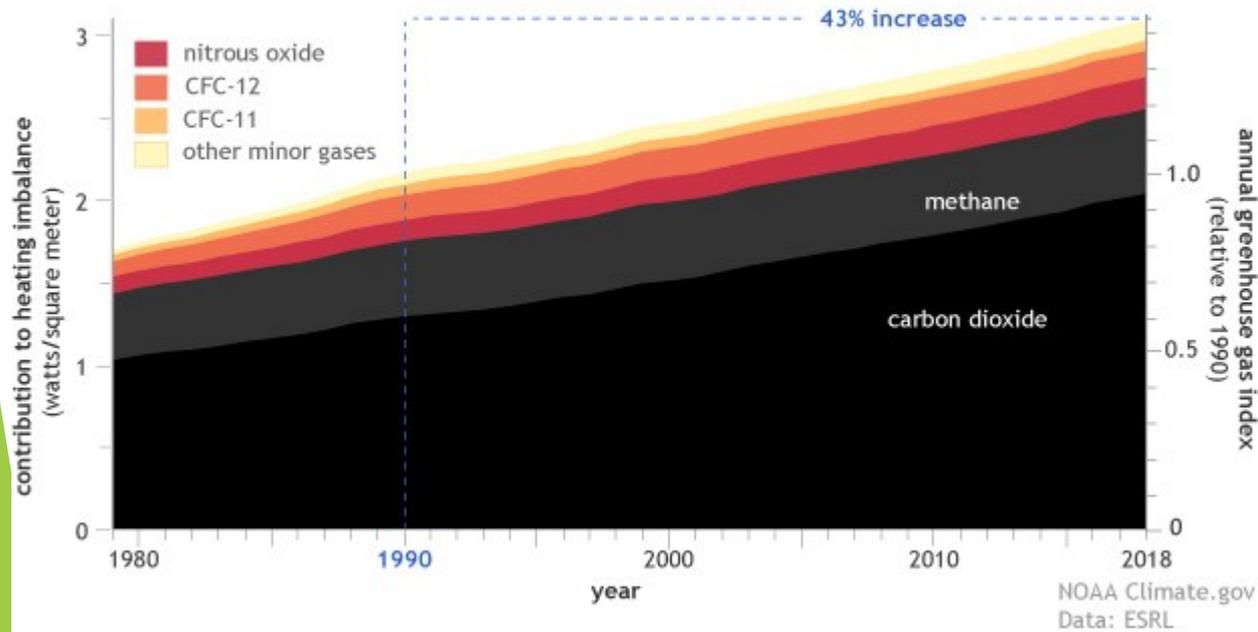
**Personal Quote: Climate Change (C2) is a Globally Pervasive, Borderless Phenomenon, owing to Man-Made Energy Imbalance, resulting the Unnatural Extinction of Species in the Natural World, along with Unnatural "Landscaping" of the Geographical Environment**

# C2- The Energy Imbalance

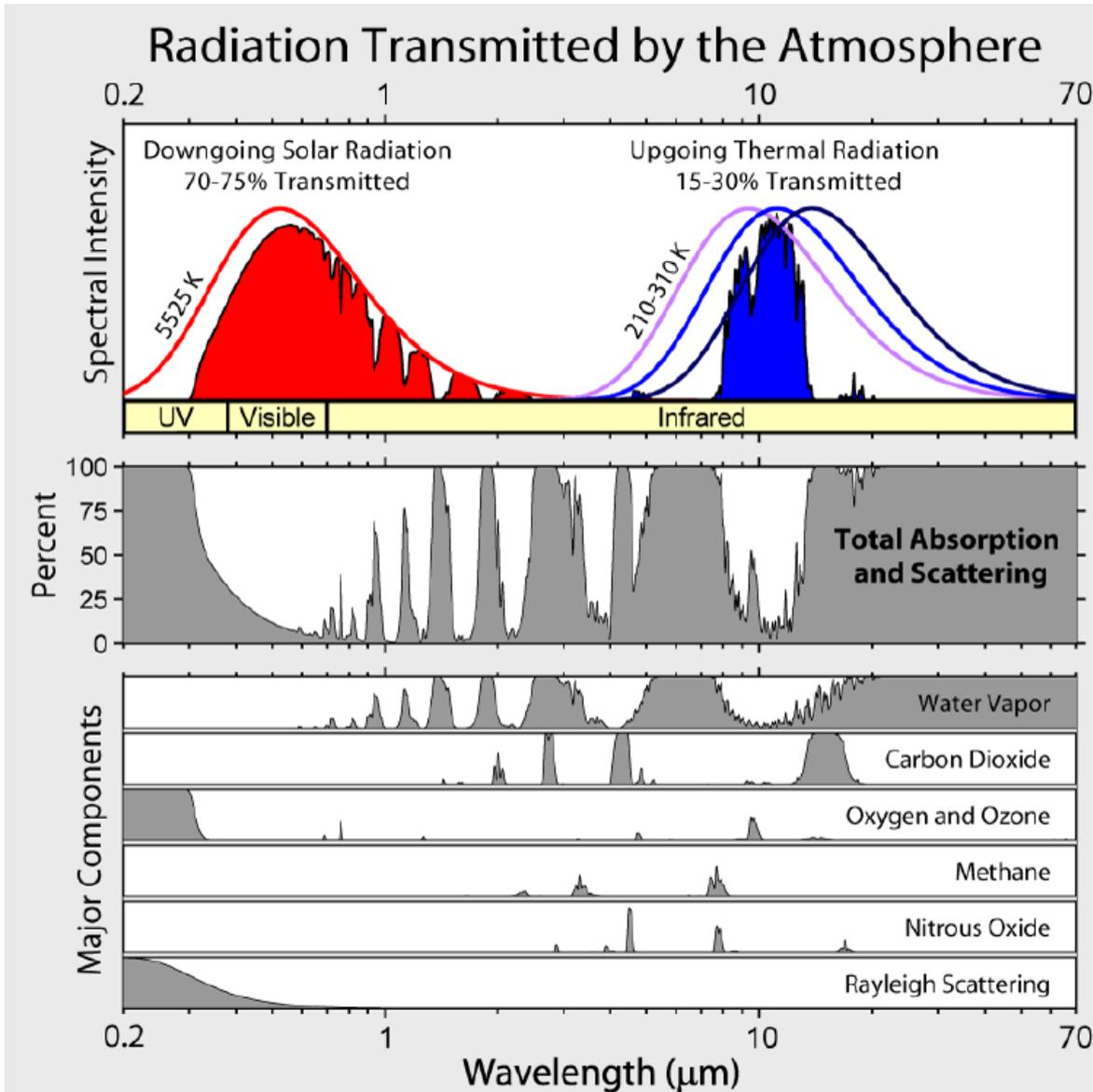
CO<sub>2</sub> during ice ages and warm periods for the past 800,000 years



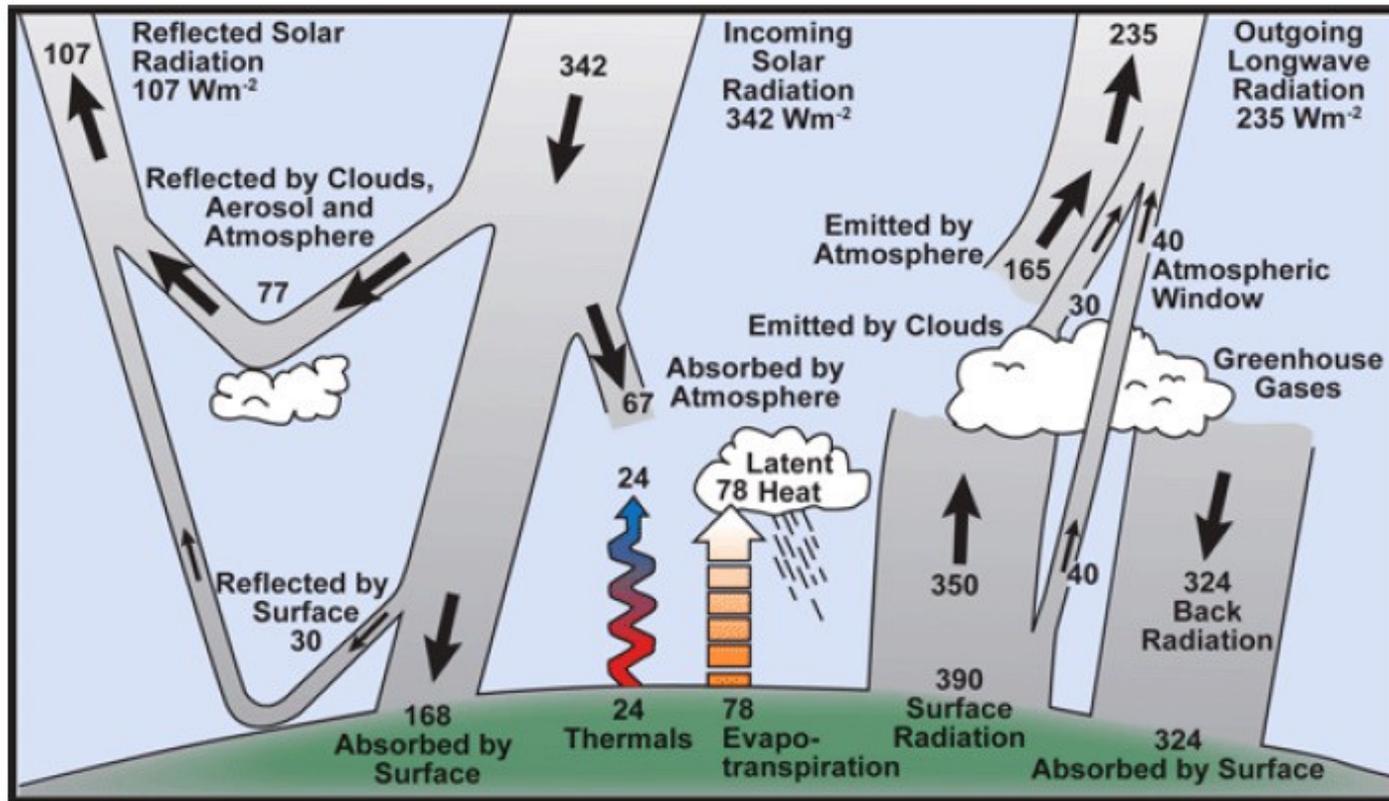
Influence of all major human-produced greenhouse gases (1979-2018)



# C2- The Energy Imbalance (cont'd)



# C2- The Energy Imbalance (cont'd)



**GWP of GHGs owing to Human Activity:**  
**Global Warming Potential relative to 1 unit of CO<sub>2</sub>.** Depends on radiative absorption, spectral location and lifetime in the atmosphere

GHG	GWP for 100 years
CO <sub>2</sub>	1
CH <sub>4</sub>	23
N <sub>2</sub> O	296
HFC - 23	12 000
HFC - 134a	1 300
SF <sub>6</sub>	22 200

Source: IPCC Third Assessment Report (2001).

# Tragic Impacts of C2



## SOCIAL AND ECONOMIC IMPACT OF CLIMATE CHANGE



The cost of adapting coastal areas to rising sea levels

Relocation of whole towns



Loss of the capacity to work due to heat

Shrinking productivity of harvests



Prices of basic foodstuffs and consumer goods will rise



More wars to gain access to limited resources

Extreme meteorological phenomena will cause widespread poverty



Fresh water will be in short supply in some areas

Diseases will spread due to higher temperatures



# Tragic Impacts of C2(cont'd)

- ▶ What is Getting Impacted ?
  - ❑ Water - Temperature Rise and Population Stress
    - ❑ Ground Water Depletion, Aquifer Subsidence and Pollution
    - ❑ Ocean Acidification with increased CO2 absorption

Groundwater extraction  
**70% faster**  
than estimated  
earlier



**300**  
cubic km  
groundwater  
lost in 6 years



## NO CLARITY ON HOW MUCH GROUNDWATER IS LEFT

Delhi needs  
**1 cubic km**  
water a year; likely to  
be worst affected



Ground and  
surface  
water add  
up to total  
utilisable water



**Niti Aayog has warned that Delhi could run out of groundwater by 2020**

(one cubic km = 1 trillion litre)  
Source: National Geophysical Research Institute

## POTENTIAL EFFECTS ON ECOSYSTEMS

Specific effects of ocean acidification to a variety of ocean ecosystem, around the globe.

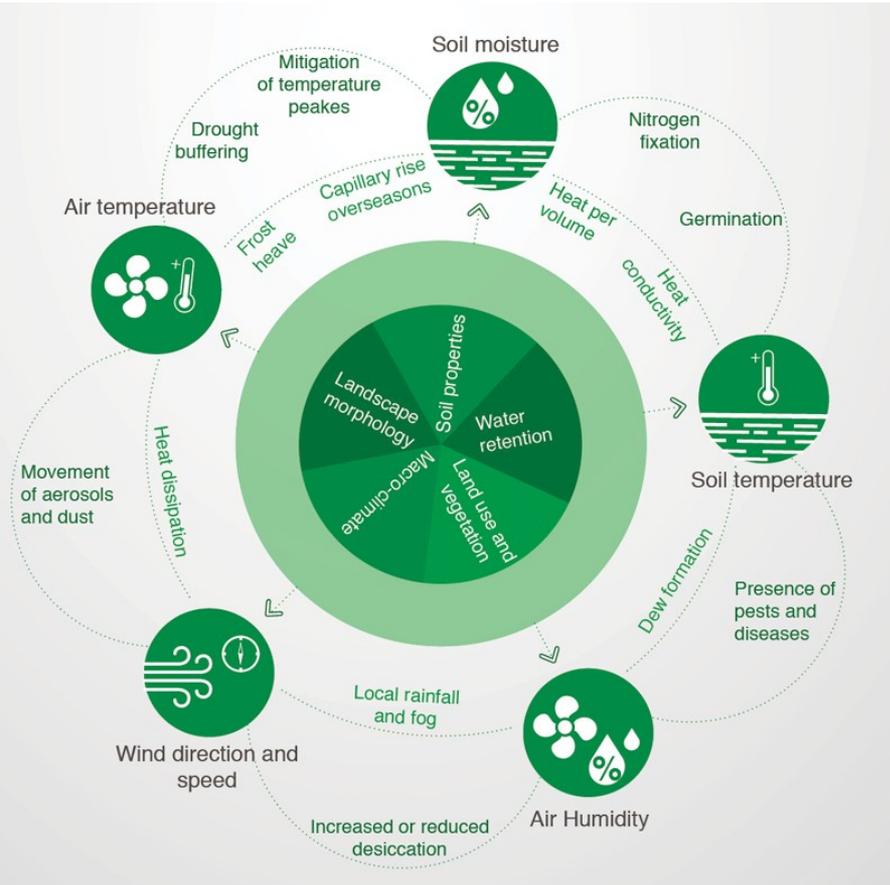
### • THE OPEN OCEAN ECOSYSTEM:

- Based on plankton, which serves as the foundation of the marine food chain.
- Planktonic species including coccolithophores, foraminifera, and pteropods need carbonate ions to build their shells.
- If ocean acidification increases,
  - ✓ Carbonate based planktonic species may decline.
  - ✓ A range of species including fish, seals, whales could lose their preferred food.

Cont.....

# Tragic Impacts of C2(cont'd)

- ▶ **What is Getting Impacted ?**
  - ❑ **Soil, Biodiversity - Temperature Rise, Water Depletion**
    - ❑ **Micro-climate destruction - soil destruction and desertification, compounded by monoculture**
    - ❑ **Insects, Flora/Fauna - agriculture, bio-health**

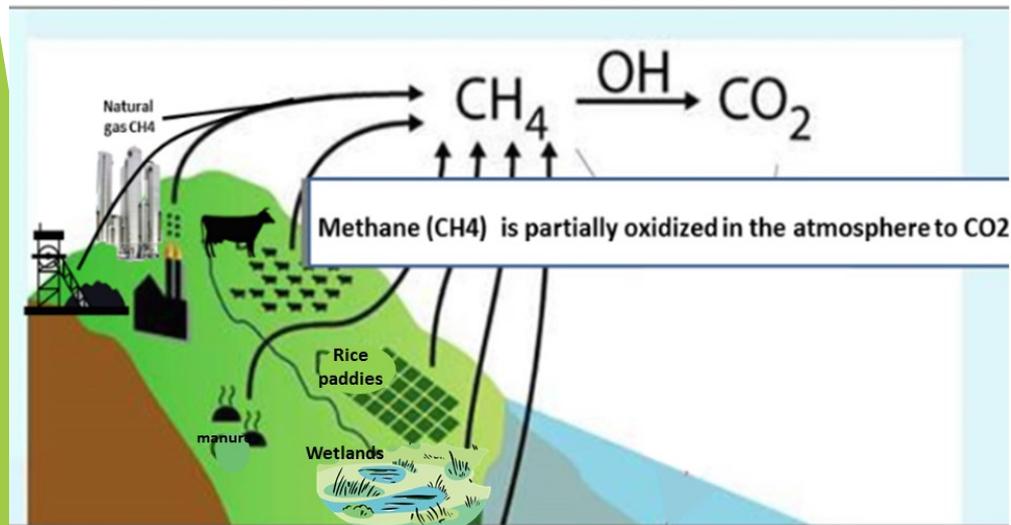


# Tragic Impacts of C2(cont'd)

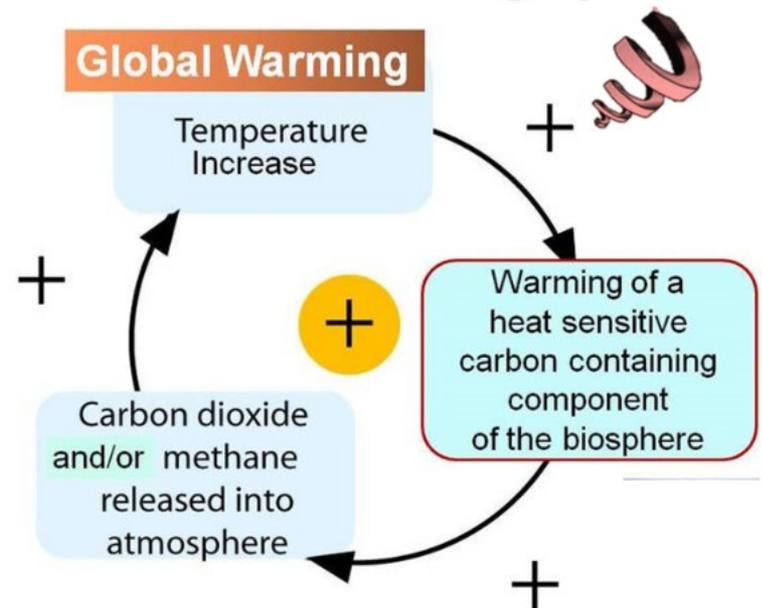
- ▶ What is Getting Impacted ?
  - ❑ Geography, Landscapes - Temperature Rise
    - ❑ Methane, other GHG's accelerate warming and C2
    - ❑ Melting Permafrost (CH<sub>4</sub>'s), Melting Sea Ice and Polar and Snow Caps (Heat Absorption, Reflection)

**Methane (CH<sub>4</sub>) is a very powerful carbon greenhouse gas**

Methane has 72 times the global warming of CO<sub>2</sub> for 20 years after emissions



**Amplifying +ve carbon feedback vicious recurring cycle**



# Tragic Impacts of C2(cont'd)

- ▶ What is Getting Impacted ?
  - Geography, Landscapes - Temperature Rise
    - Melting Glaciers, Ice Sheets alters Water Cycle, Rainfall, Ocean Salinity, Currents, Wind Patterns

## HOW CLIMATE CHANGE IMPACTS WEATHER **THE SCIENCE**

CHANGES IN THE WATER CYCLE ARE INCREASING THE RISK OF DROUGHTS AND FLOODS.



Higher temperatures mean there is more evaporation from the land and sea into the atmosphere.



As air gets warmer, it can hold more water vapor. This can lead to more intense rainstorms.



Intense rainstorms increase the risk of flooding. Much of the water runs off into rivers and streams, doing little to dampen soil.



This, combined with increased temperatures, increases the risk of drought.

**EVAPORATION**

**PRECIPITATION**

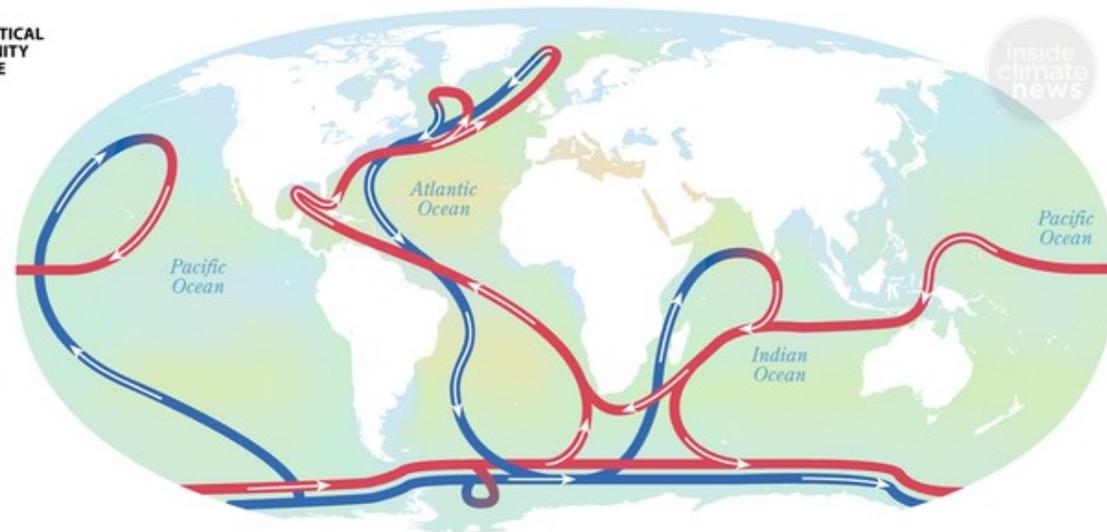
**WATER  
CYCLE**

**RUNOFF**

## Thermohaline Circulation: The Great Ocean Conveyor Belt

Currents circulate water through the world's oceans like a giant conveyor belt, carrying heat from the tropics toward the poles and sending colder water back in deep ocean currents. Wind, temperature and salinity help drive them. This simplified map shows the pattern.

PRACTICAL  
SALINITY  
SCALE



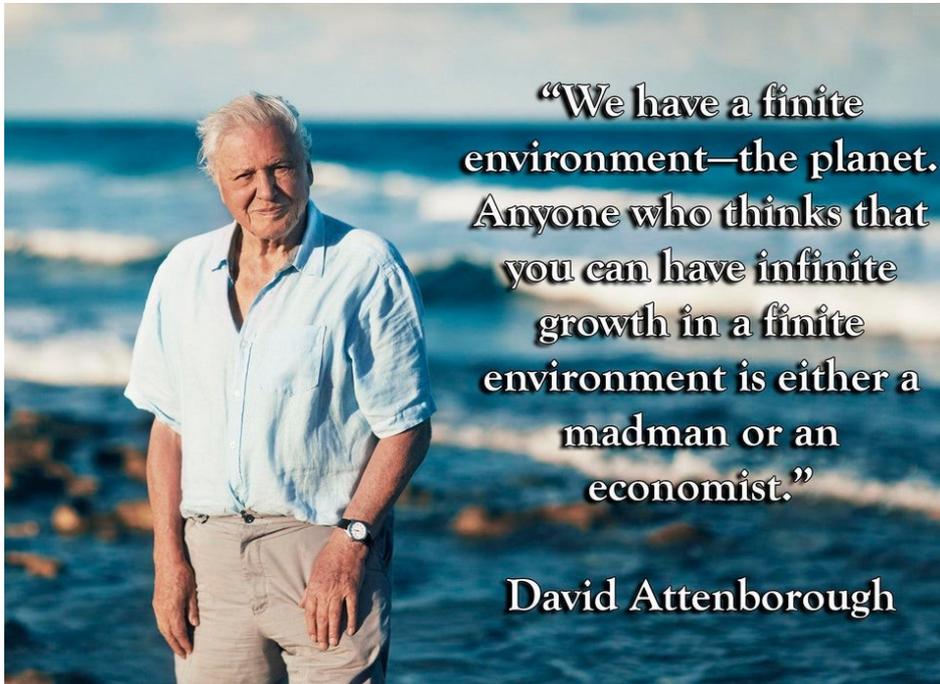
SOURCE: NASA

PAUL HORN / InsideClimate News

# Connecting the Dots

## ▶ How is India Impacted ?

- ❑ Land Microclimate & Coastal Ecosystem Destruction, Ground Water Exploitation hurt Agriculture, Fishing
- ❑ Loss of main livelihood and basic means to survive leads to mass migration to Urban areas and impose further stress on resources in a vicious cycle
- ❑ Urban areas become further unsustainable from an energy, water, sewage, mobility and shelter standpoint

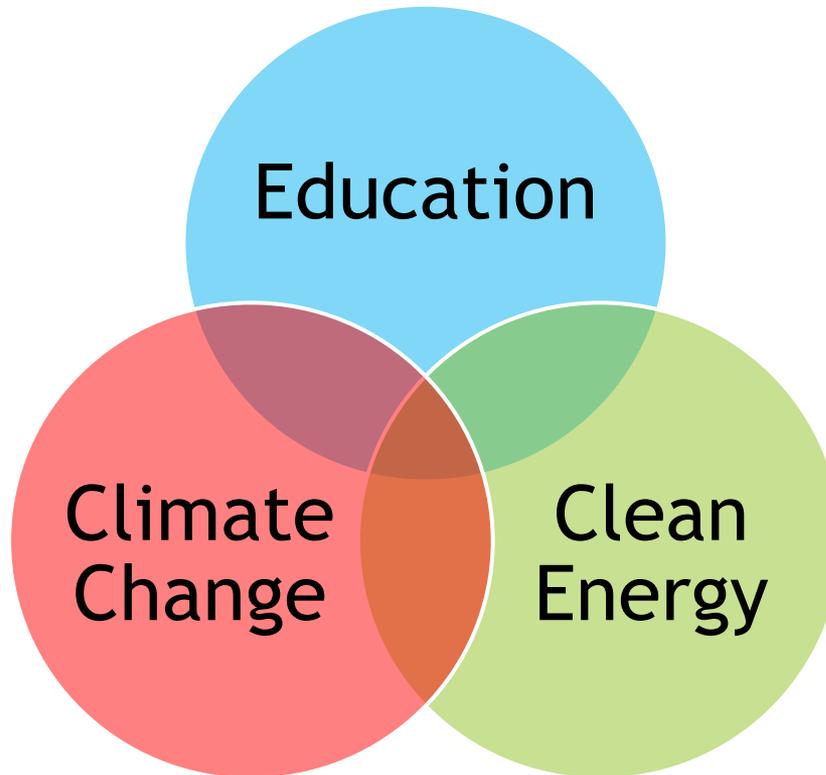


# Connecting the Dots (cont'd)

## ▶ How Do We Stem the Rot ?

- ❑ C2 is a subject that impacts the entire Natural World - therefore understanding how the Natural World and Human Society works is paramount
- ❑ Leverage Technology to identify, measure, track and determine trends for the current negative markers
- ❑ Leverage Technology as a key tool to mitigate local/region specific challenges related to water, soil, ocean, energy, shelter keeping the energy balance in mind. How do we mitigate forced rural to urban migration
  - ✓ Efficient, Renewable & Clean Energy Sources for Agriculture, Lighting, Cooking, Mobility, Computing, Community Services
  - ✓ Rainwater, Groundwater Storage and Management
  - ✓ Biodiversity, Ocean Ecosystem and Soil Microclimate Preservation
  - ✓ Community Waste/Sewage Management
  - ✓ Education

# Connecting the Dots (cont'd)

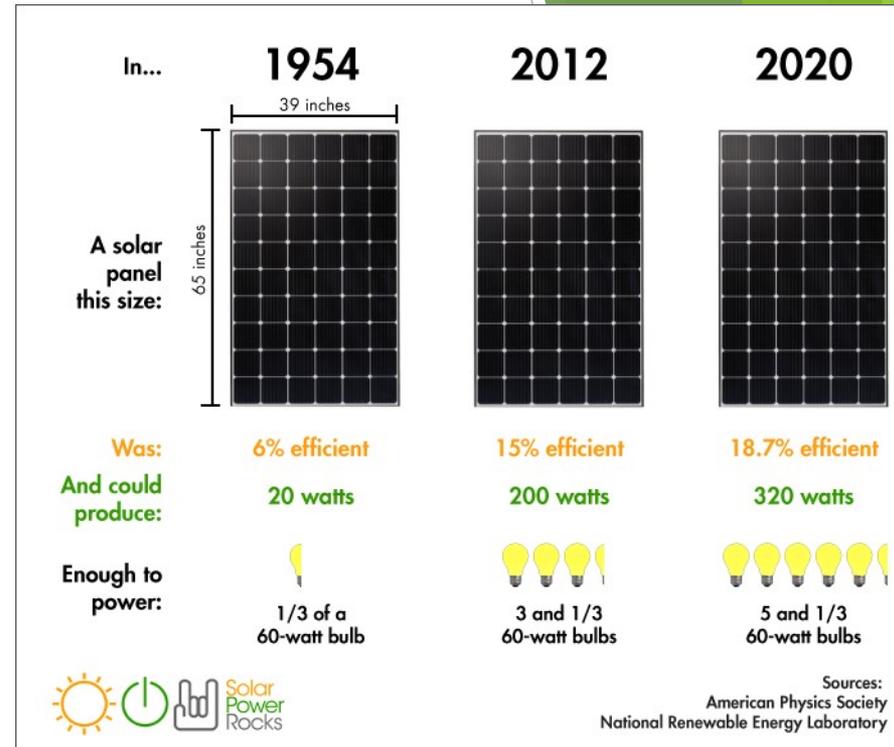


# Clean Energy for Semi-Urban, Rural India

## ▶ Key Considerations

- ❑ High quality energy feed
- ❑ Low Cost per KWh, Financing options
- ❑ Self Sufficiency at Local/Regional level - DRE:  
Decentralized Rural Energy
- ❑ Energy efficient with minimal losses
- ❑ Minimal waste, recycling
- ❑ Environmental impact assessment
- ❑ Meets disparate power/energy needs for:
  - ✓ Agriculture
  - ✓ Lighting
  - ✓ Cooking
  - ✓ Mobility
  - ✓ Computing
  - ✓ Community services

# DRE - Solar Grids (Micro, Nano, Pico)



## ▶ Key Considerations

- ❑ Battery Backup for 24x7 Always-On Power
- ❑ Battery Maintenance, Cleaning of Solar Panels
- ❑ Progressive scalability - cost of addition to capacity
- ❑ Picogrids/Nanogrids - local efficiency, minimize environmental impact
- ❑ Recycling panels, batteries - Safety, 2<sup>nd</sup> life capacity

# DRE - Hybrid Solar and Wind Farms



## What is the Wind Power Equation?

$$Power = \frac{1}{2} \times \rho \times \pi \times r^2 \times C_p \times CF \times v^3 \times N_G \times N_B$$

P = power generated in Watts

v = velocity of the wind in m/s

$\rho$  = density of the wind in kg/m<sup>3</sup>

$\pi r^2$  = swept area, where r = blade length in m

$C_p$  = Power Coefficient

$C_F$  = Capacity Factor

$N_G$  = generator efficiency

$N_B$  = gearbox efficiency



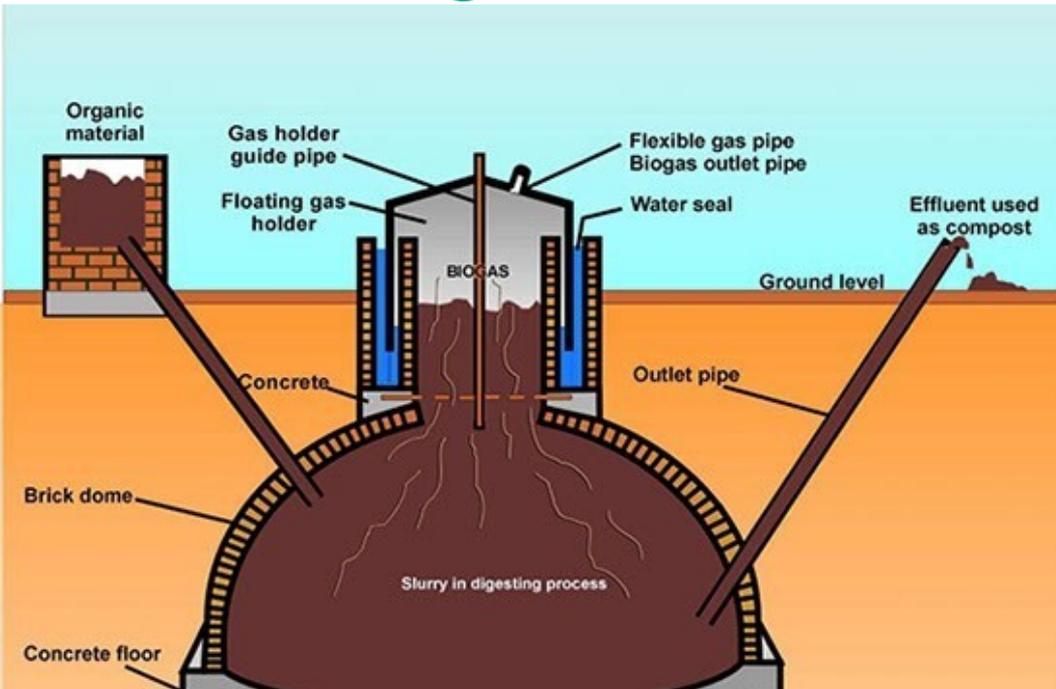
Recorded with  
SCREENCASTOMATIC



## ▶ Key Considerations

- ❑ For rural context, hybrid wind capacity factor complements solar
- ❑ Power ~ (Wind Speed)<sup>3</sup>. Halving wind speed ~ 1/8<sup>th</sup> original power
- ❑ Turbine blades size & position to account for power
- ❑ Battery Maintenance, Cleaning of Solar Panels
- ❑ Turbine and Generator Maintenance
- ❑ Recycling panels, batteries - Safety, 2<sup>nd</sup> life capacity

# DRE - Biogas Plants for Cooking

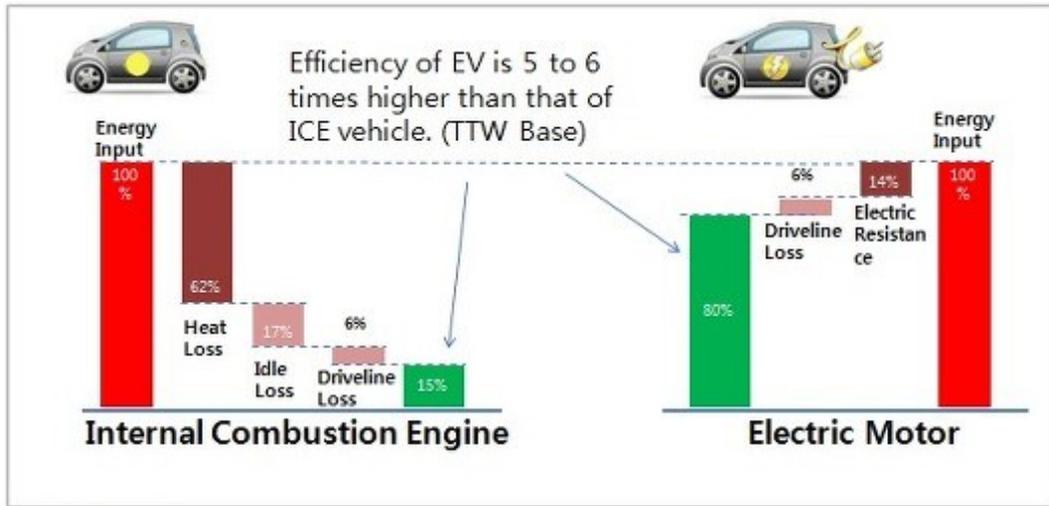


## ▶ Key Considerations

- ❑ Excellent specifically for organic and traditional farms with livestock
- ❑ Common units for multiple households
- ❑ Energy saved in lieu of cooking gas delivery through Ujjwala scheme
- ❑ Excellent substitute for firewood (saves 4.5 tons of firewood and associated GHG's emission - CH<sub>4</sub>)

# Electric Mobility - Overview

## Efficiency EV vs. ICE



TTW: Tank to Wheel  
ICE: Internal Combustion Engine

Source: US Environmental protection Agency (EPA)

## Higher Efficiency can justify the EV's Future

Industry Division

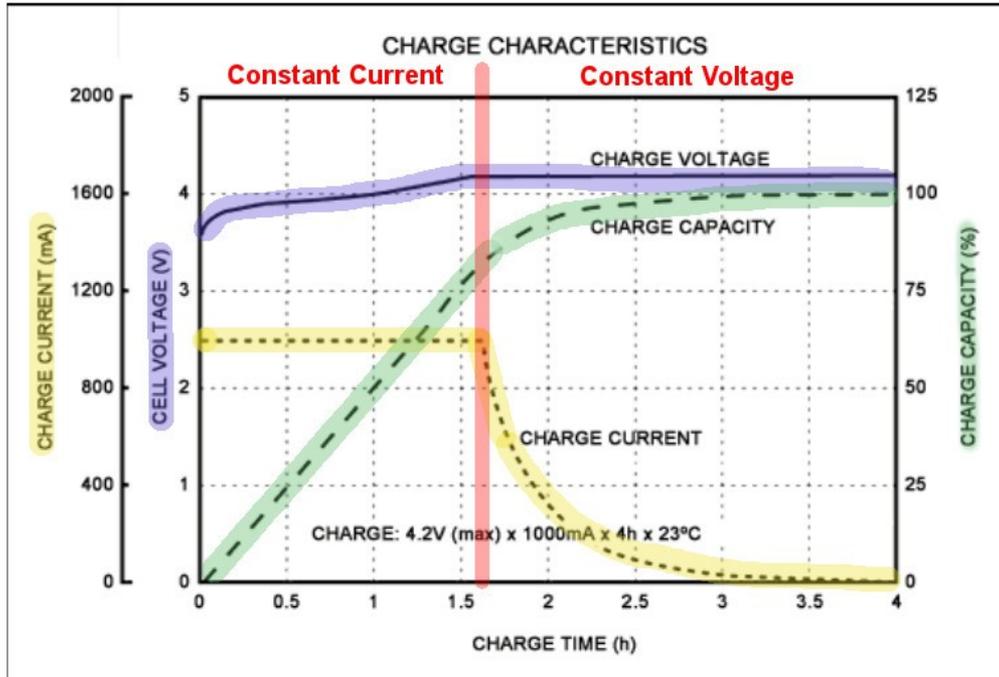
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### ► Key Considerations

- ❑ Form Factor - Rural EV adoption ripe for 2W/3W, Farm Equipment
- ❑ Entry Cost, Maintenance/Operations Cost for Charging
- ❑ 2W/3W Distances are nominal. Tractor usage/load likely heavy
- ❑ Technology - Fixed Battery versus Swappable Battery

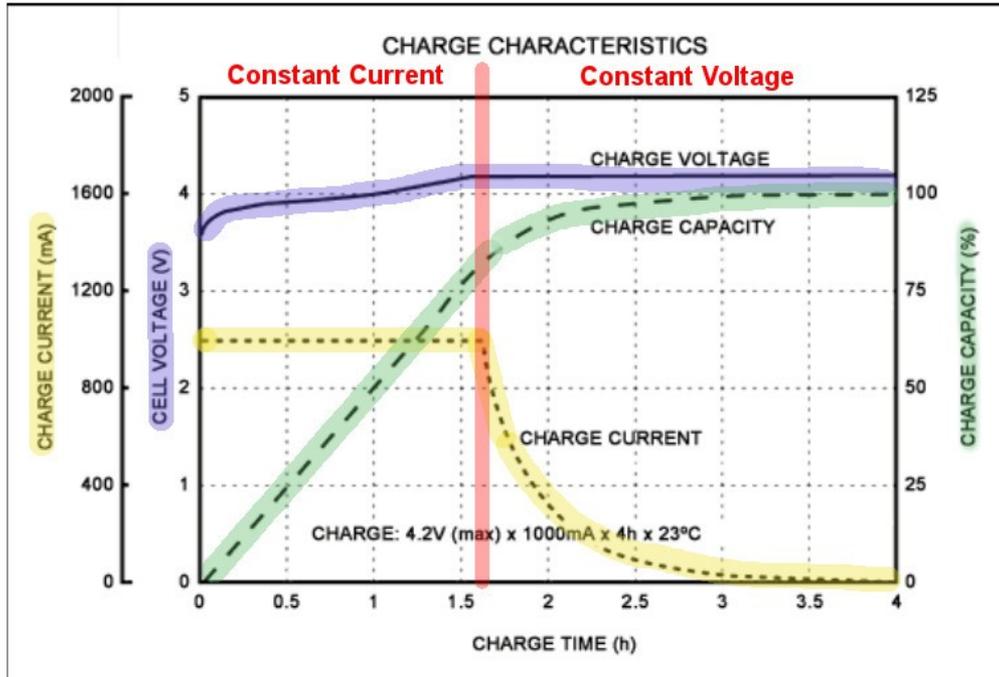
# Electric Mobility - Fixed Battery



## Key Considerations

- ❑ Fixed Battery Charge time with 5A phase at 2 - 3 hrs for a 2W/3W with energy density of 2KWh. Low downtime even in Micro-grid
- ❑ Fixed Battery Charge time with 15A phase at 6 - 8 hrs for Electric Tractor with energy density of 15KWh. Suboptimal use a concern
- ❑ Fixed battery lease energy model attractive to offset cost
- ❑ Charge Points housed with local Micro Grid for Thermal, Safety
- ❑ IoT-based Telemetry to local Grid for Proactive Maintenance

# Electric Mobility - Battery Swap

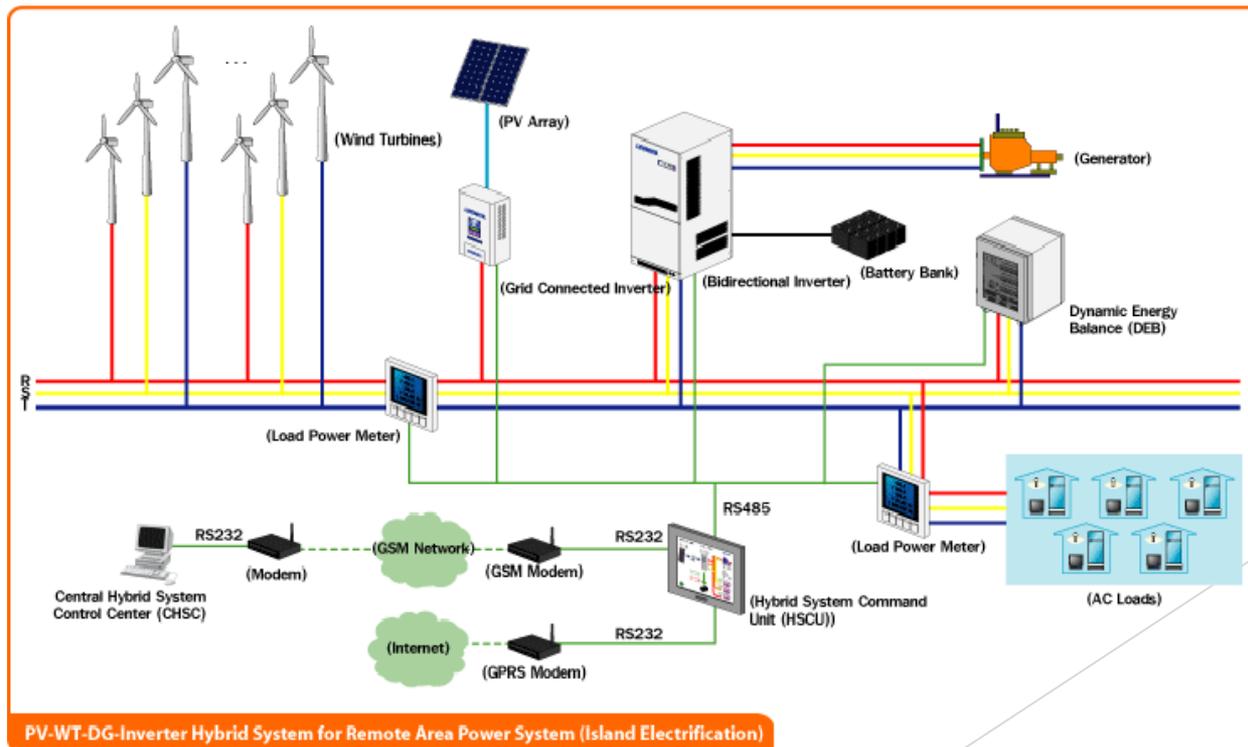


## Key Considerations

- ❑ Fixed Battery Charge time with 5A phase at 2 - 3 hrs for a 2W/3W with energy density of 2KWh. Suboptimal ROI and User Experience
- ❑ Fixed Battery Charge time with 15A phase at 6 - 8 hrs for Electric Tractor with energy density of 15KWh. Higher Utilization and ROI
- ❑ Pay as per use, and shared energy model attractive to offset cost
- ❑ Micro Stations housed with local Micro Grid for Thermal, Safety
- ❑ IoT-based Telemetry to local Grid for Proactive Maintenance

# Energy Kickstarter Projects

- ▶ Integrated Pico Energy Project in Order
  - ❑ Street, Home Lighting, LP Electronics
  - ❑ Distributed Solar Panel
  - ❑ Distributed Mini Wind Turbine
  - ❑ Area specific common Battery Backup
  - ❑ Distributed Energy IoT enabled Monitoring



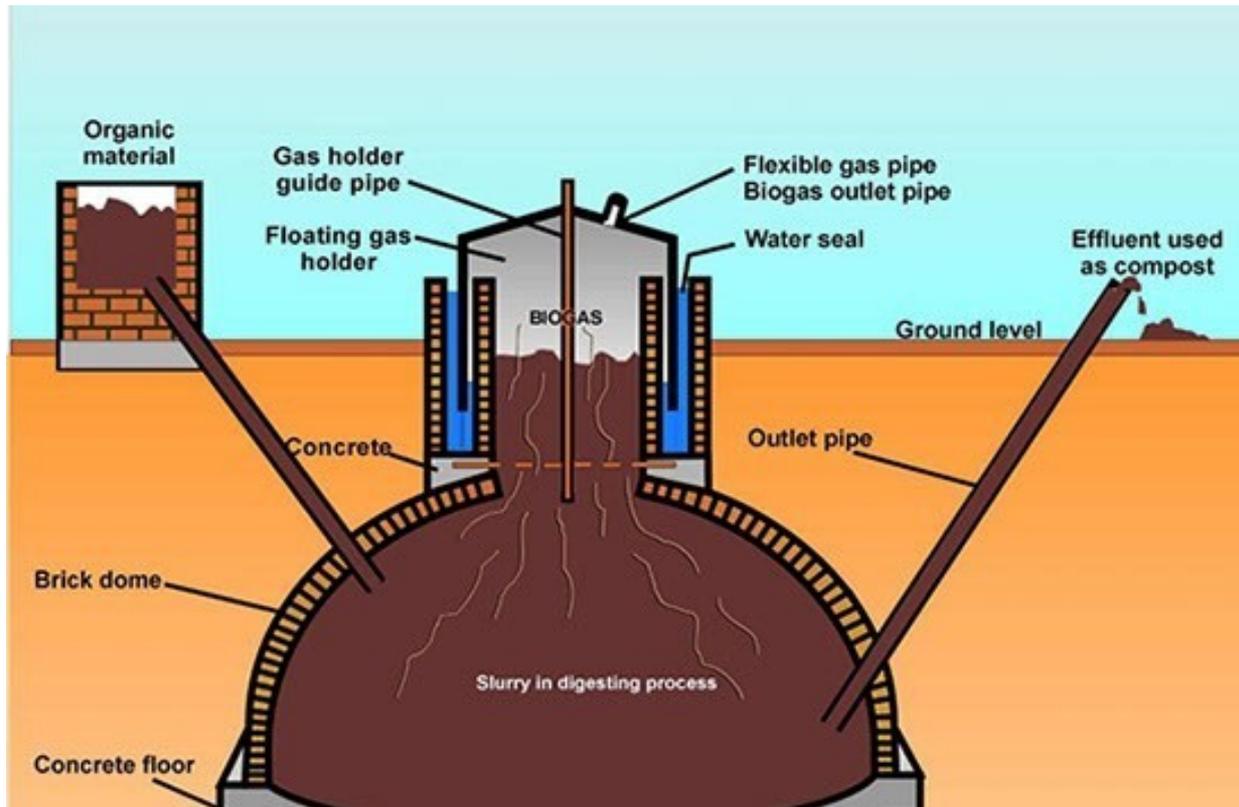
# Energy Kickstarter Projects (cont'd)

- ▶ **Scale Pico Energy Project to Micro in Order**
  - ❑ **Add Fixed Battery Charging Points in Grid Station**
  - ❑ **1 - 3 15A points for 2KWh 2 Wheeler or 3 Wheeler**
  - ❑ **IoT enabled Monitoring for Charging points**

# Energy Kickstarter Projects (cont'd)

## ▶ BioGas powered Cooking

- ❑ Micro unit for 1 - 3 homes powered using animal/farm organic matter
- ❑ Biogas to feed 1 - 3 pipe outlets from a common feed
- ❑ Low cost CO/CH<sub>4</sub> gas detector indicator for safety



# Education - Technology, Reworking Knowledge Transfer

**FINANCIAL RESOURCES**

Women are granted fewer and smaller loans than men

Women in forestry, fishing and agriculture receive just **7%** of total agriculture investment

**PRODUCTIVE RESOURCES**

Women make up **43%** of the agriculture workforce in developing countries

If women had equal access to productive resources as men, they could increase yields on their farms by as much as **20% -30%**

**ACCESS TO DECISION-MAKING FORAS**

Women hold **14%** of management positions in the agricultural sector

At the UN Climate Change Summits between 2000-2010, only **30%** of registered country delegates were women

**KNOWLEDGE AND TECHNOLOGY**

**2/3** of the world's illiterate adults are women

One study showed that women's education contributes to **43%** reduction in child malnutrition

**LAND & WATER**

In developing countries **10% -20%** of all land holders are women

Farms managed by female-headed households are between half to **2/3** the size of farms run by male-headed households

**SERVICES & MARKET**

Agriculture extension services are accessible to only **5%** of women that make up the agriculture workforce in developing countries

Energy services in West Africa have:

- reduced women's daily work by **2-4** hours
- increased women's incomes
- improved education and school enrolment

**EQUAL ACCESS TO RESOURCES AND POWER**

for

**FOOD SECURITY** in the face of **CLIMATE CHANGE**

AVAILABILITY | STABILITY | UTILIZATION | ACCESS

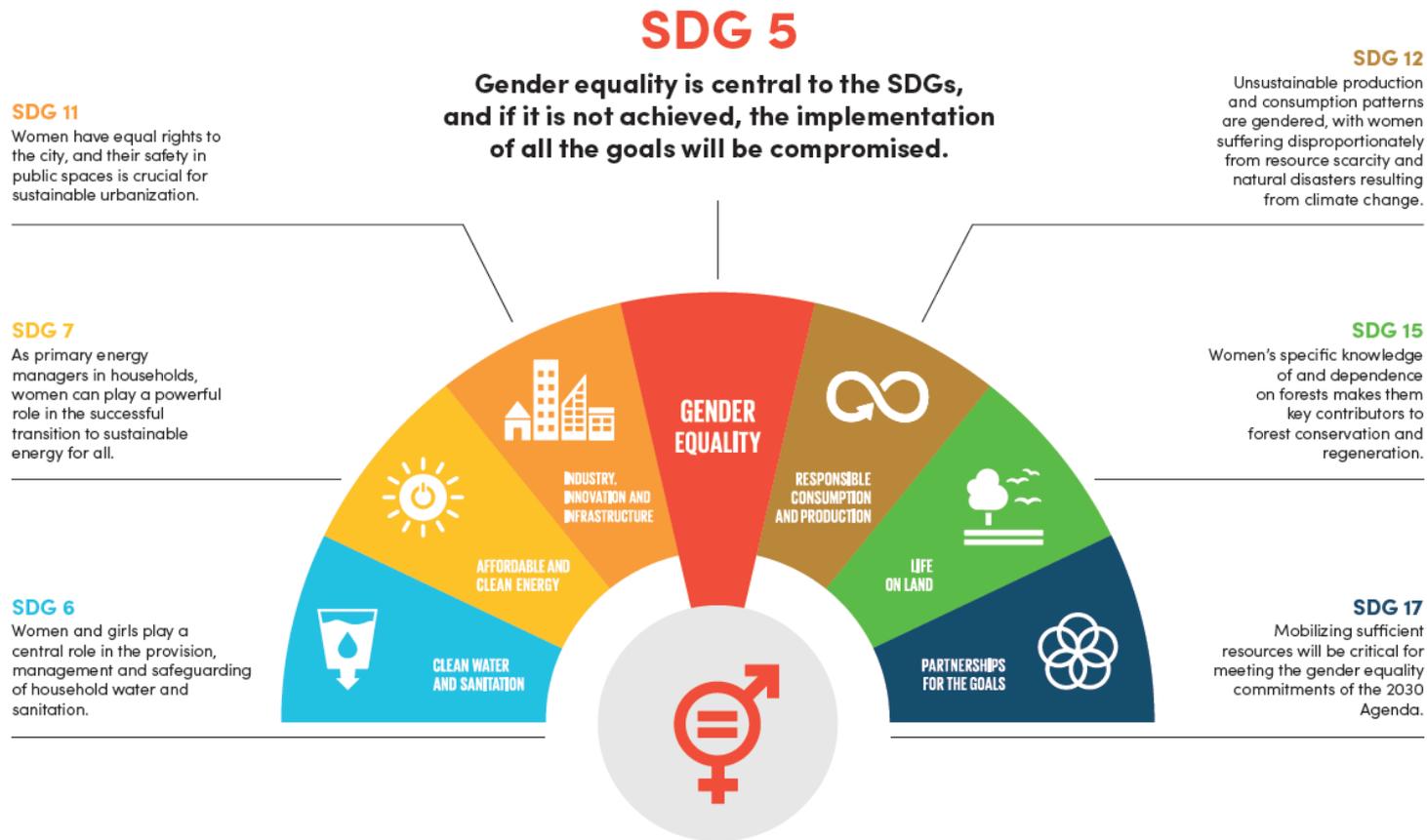
ADAPTATION | MITIGATION

www.fao.org/climatechange/micca/gender  
www.fao.org/gender

**Key Mantra: Technology as an enabler of Equitable, Bi-Directional Access to and Exponential Flow of Knowledge, Education.**

# Women's Empowerment in Education

- ▶ Rural Women's success in Microfinance, Panchayats give impetus to empower them on relevant education



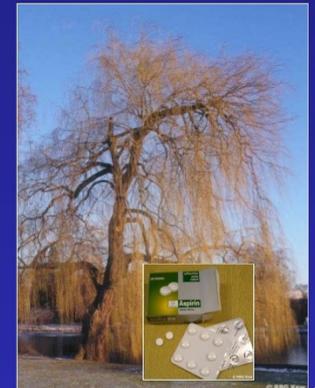
# Educating Urban India

- ▶ **Rural India has a lot to offer Urban India & Students**
  - ❑ **Organic/Traditional Farming 101: Soil Health, Water Cycle, Crop Rotation, Permaculture, Geographical landscapes**
  - ❑ **Biodiversity: Crops, Livestock, Insects, Pollination**
  - ❑ **Educating Urban India on Sustainable Farming as a means of livelihood and awareness building, knowledge sharing, based on which meaningful C2 solutions can be developed**
  - ❑ **Leverage existing Online, Distance Learning, IPR tools**



## Traditional Knowledge on Biodiversity Conservation

- Tribals follow ethics and their TK often helps to conserve Bio-Diversity.
- Over thousands of years local people have developed a variety of vegetation management practices that continue to exist in tropical Asia, South America, Africa and other parts of the world.



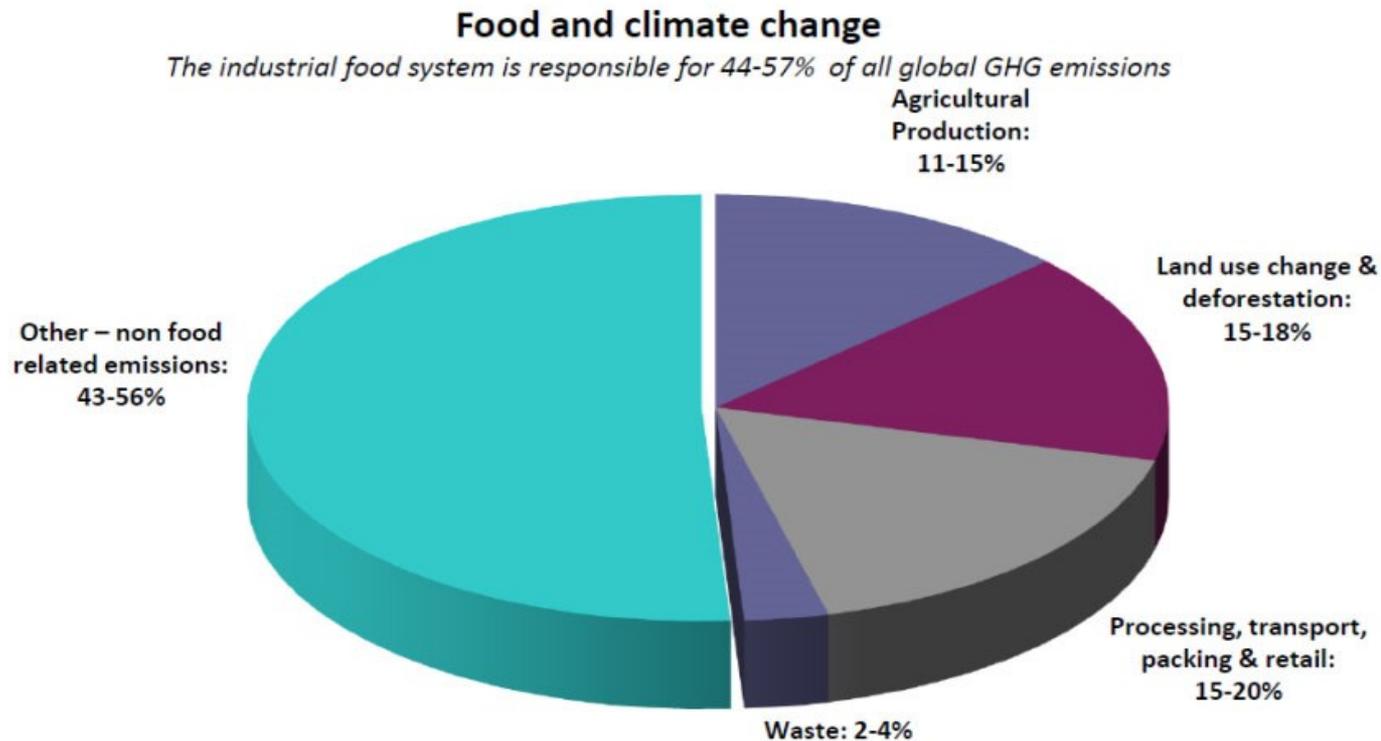
# Educating Urban India (cont'd)

- ▶ Rural India has a lot to offer Urban India & Students
  - ❑ Traditional cookware, diets (cast iron, stoneware, clay)
  - ❑ Traditional medicines
  - ❑ Educating Urban India on eons old healthy cooking and alternative health therapy as a means of livelihood and awareness building, knowledge sharing
  - ❑ Leverage existing Online, Distance Learning, IPR tools



# Educating Urban India (cont'd)

- ▶ A Shift from Calories per Acre, to “Health” per Acre
  - ❑ Norman Borlaugh bought us time with the Green Revolution, eradicating hunger while preserving land
  - ❑ Industrial Food System uses 10 calories to provide 1 calorie of questionable nutrition, inefficient v.v. Organic Farming
  - ❑ Crosspollinate the best of Organic and Industrial Farming



# Education Kickstarter Projects

- ▶ **Permaculture based Organic Garden**
  - ❑ **Organic Vegetable Garden**
  - ❑ **Permaculture approach - learn about soil, water, air**
  - ❑ <https://en.wikipedia.org/wiki/Permaculture>
  - ❑ <https://www.thebetterindia.com/109993/telangana-farmer-couple-permaculture-inspiring-india/>



# Education Kickstarter Projects (cont'd)

## ▶ Volunteer at Schools

- ❑ Disseminate mini-projects at schools as curriculum
- ❑ Minimum 5K sq ft land for Permaculture project
- ❑ Students from Std 7 to Std 12
- ❑ Video-logues and Retrospective of best practices

# Key Takeaway

## Ways to reduce your CO<sub>2</sub> emissions

Annual reduction in tonnes CO<sub>2</sub>-equivalent (tCO<sub>2</sub>e)

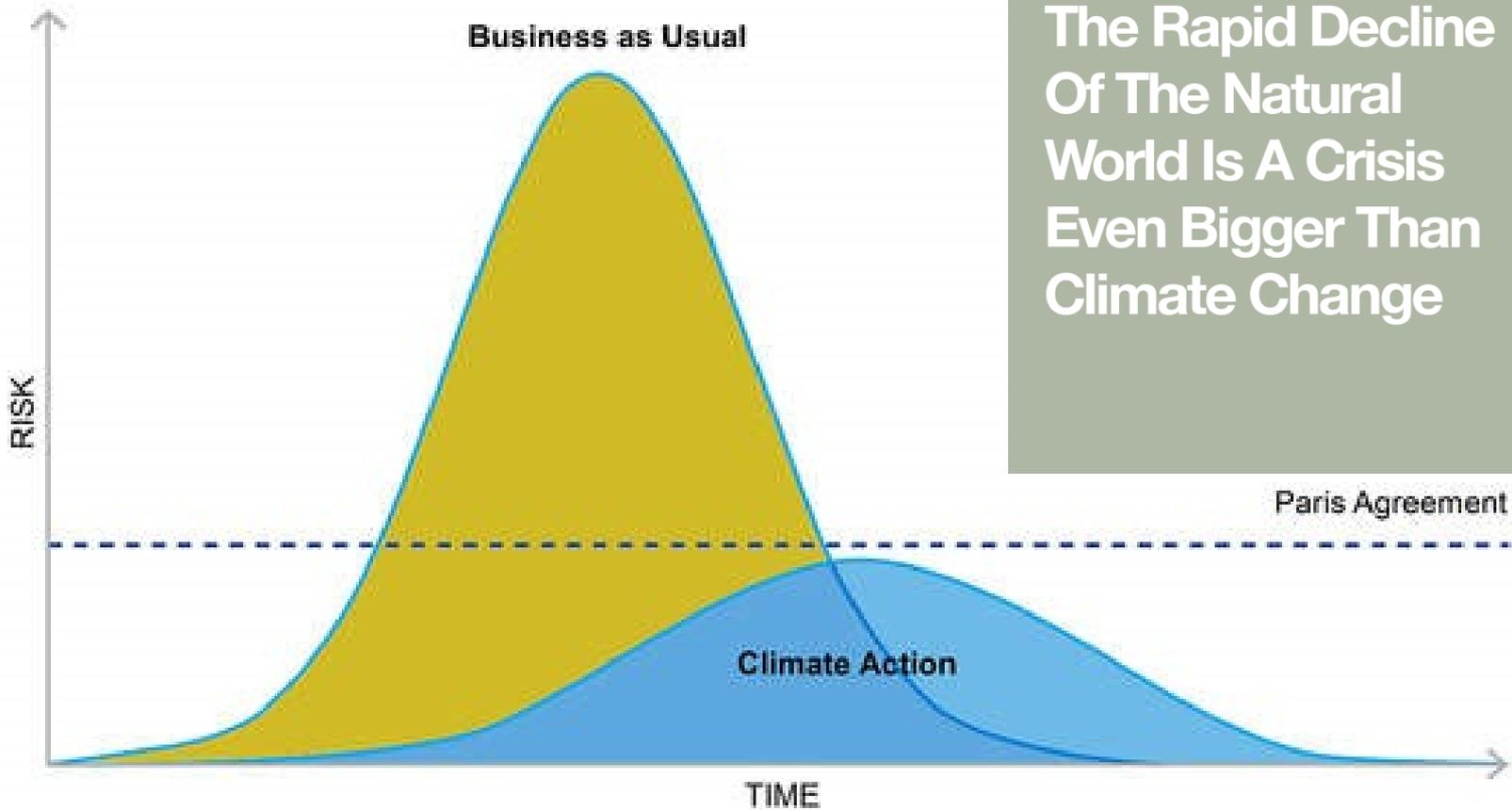


Source: Seth Wynes; Kimberly A Nicholas | Environmental Research Letters, Volume 12, Number 7

© DW

**Some Inconvenient Truths: Technology can partially address C2. The rest is up to us as individuals, societies, countries. Emphasis on the REDUCE part of the 3R's - Reduce, Reuse, Recycle**

# Key Takeaway (cont'd)



m.huffpost.com

The Rapid Decline  
Of The Natural  
World Is A Crisis  
Even Bigger Than  
Climate Change

Paris Agreement

TIME

**Flatten the Energy Curve - bring NUCLEAR Energy back onto the table for large scale electrical power**

# Hope and Consequent Action is a Great Thing ... Let Us Get To Work !



“Human beings are the  
greatest problem-solvers  
our planet has ever  
known.

We are just yet to apply  
ourselves to this problem  
with the scale and  
urgency it requires.”

David Attenborough  
Broadcaster and naturalist

Q&A

Thank You !