



Climate Change and Sustainability Concepts

Key Terms

Weather

- ▶ A **short-term phenomenon**, describing atmosphere, ocean and land conditions **hourly or daily**
- ▶ **Day-to-day state of the atmosphere**, and its short-term (minutes to weeks) variation
- ▶ **Weather is not constant can change** in just a few minutes or hours.

Climate

- ▶ Changes in the **long-term averages of daily weather** defines climate of the region
- ▶ “Climate is generally defined as **average weather**”.
- ▶ Climate **changes over longer time frames.**



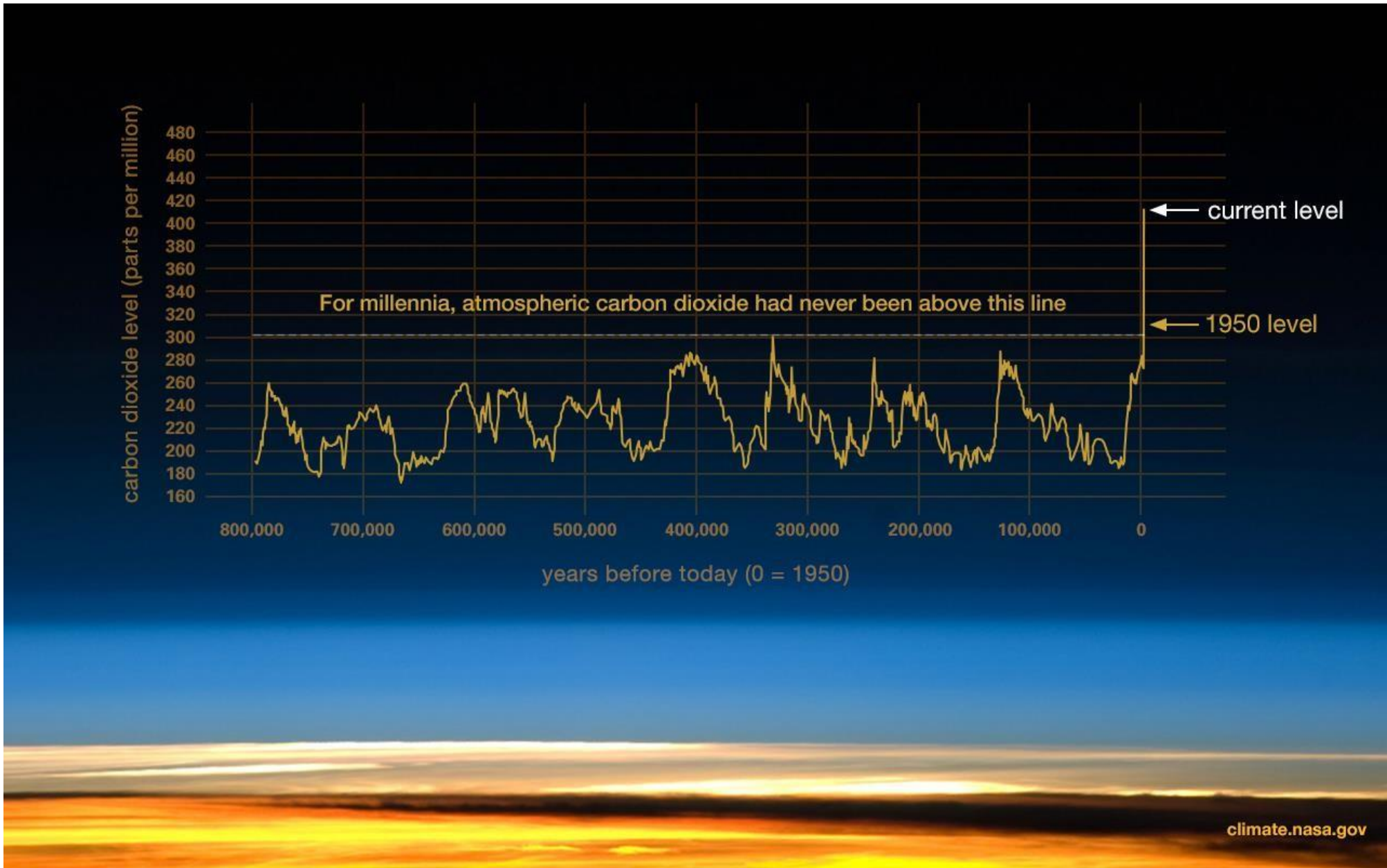
Definition of Climate Change

- ▶ “A change in the state of the climate that can be identified (e.g. using statistical tests) by **changes in the mean and/or the variability of its properties**, and that persists for an extended period, typically **decades or longer**.
- ▶ It refers to any change in climate over time, whether due to natural variability or as a result of human activity.”

- Intergovernmental Panel on Climate Change (IPCC)

UNFCCC – Attributes it to human activity in addition to the natural climate variability

Global climate is a description of the climate of a planet as a whole, with all the regional differences averaged

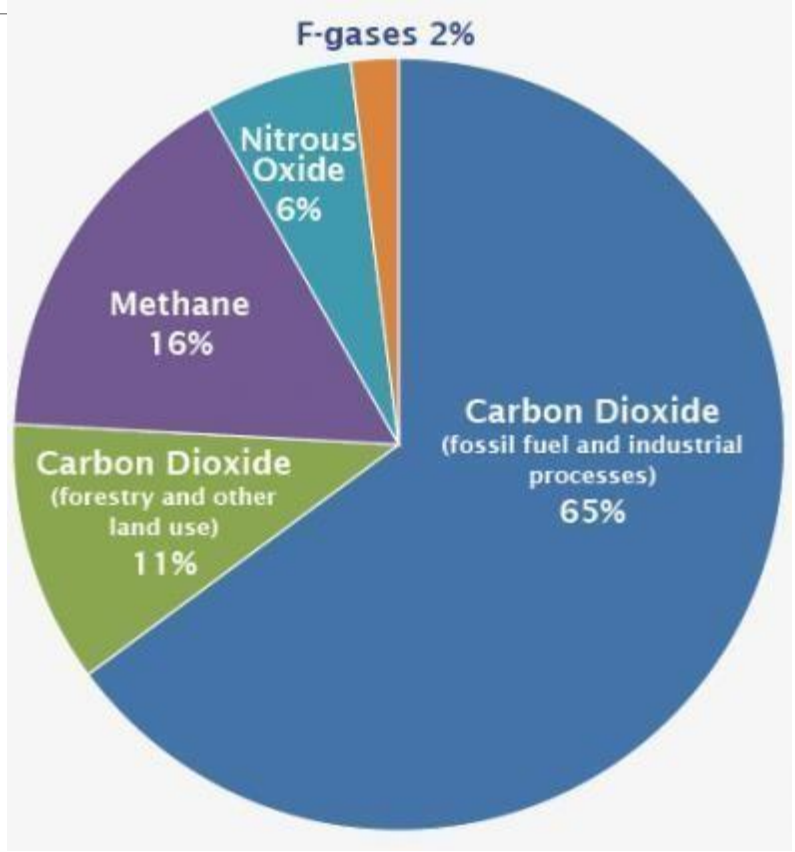
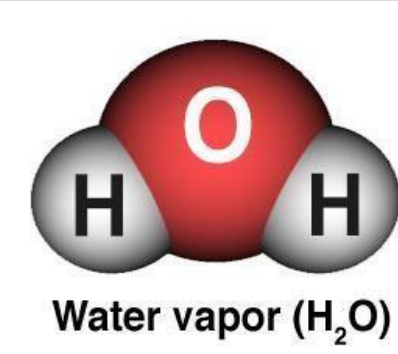
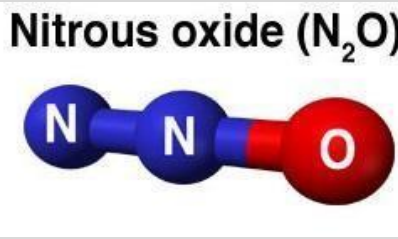
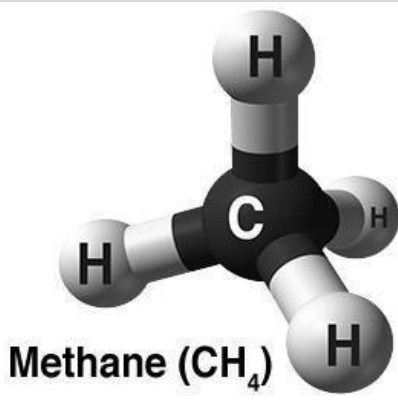
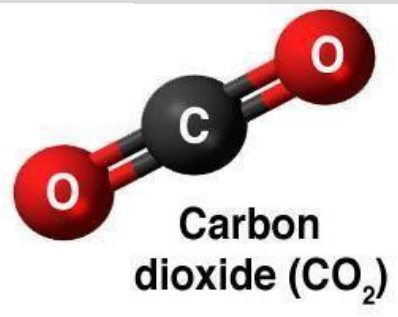


Carbon dioxide levels today are higher than at any point in at least the past 800,000 years.

Why is Climate Changing?



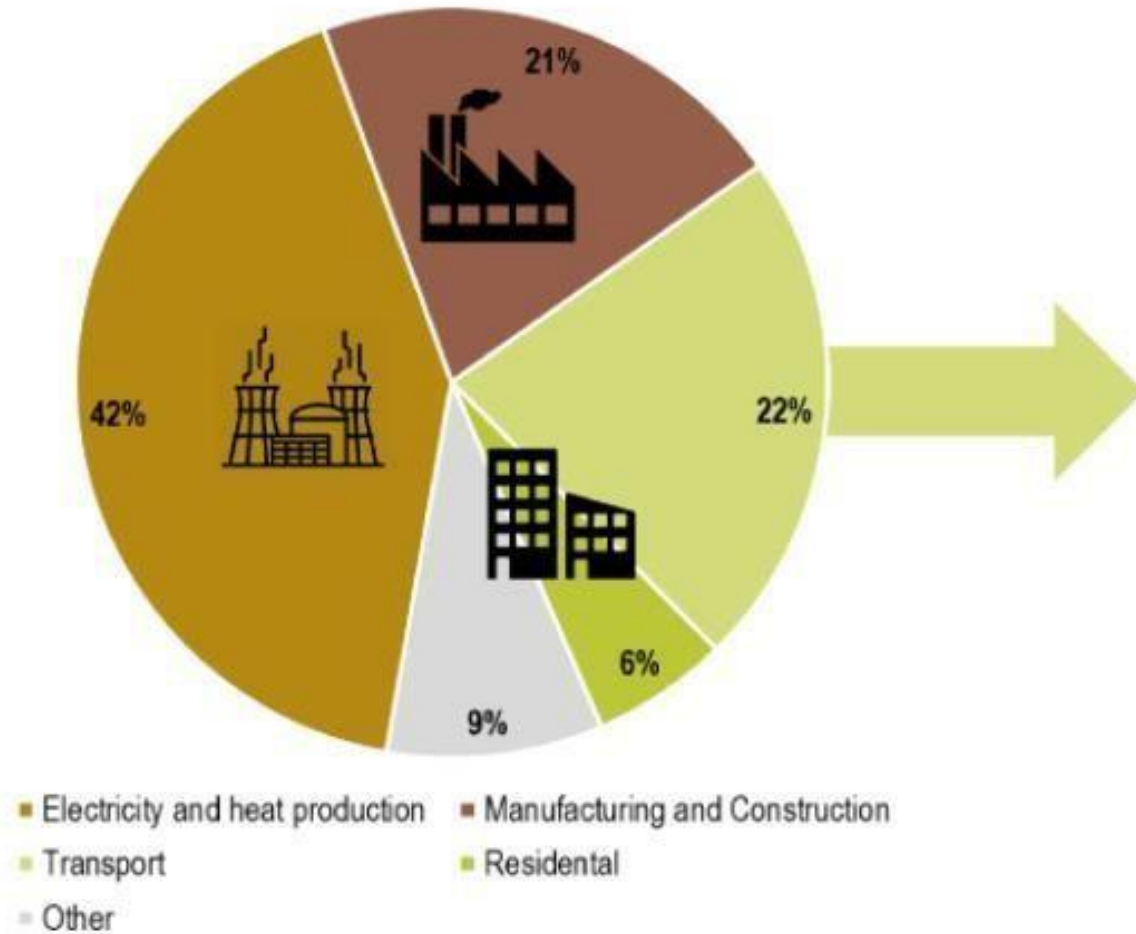
GHG Emissions



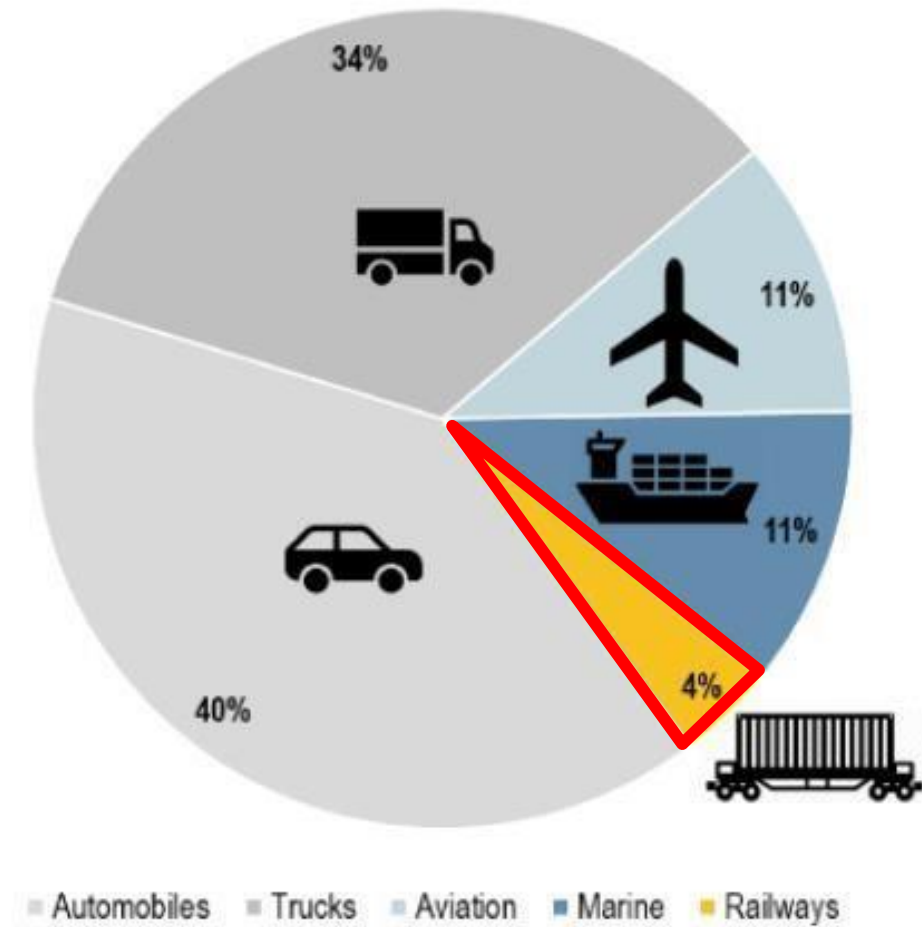
Global GHG Emissions by Gas

Global GHG Emissions by Sectors

CO2 Emissions by Economic Sector



CO2 Emissions by the Transport Sector



Global Warming



Sunlight

Earth requires greenhouse gases so that living beings can survive

BUT

We add more greenhouse gases every day

What are greenhouse gases?
Gases that contribute to the greenhouse effect by absorbing infrared radiation, e.g. carbon dioxide, Methane, Nitrous oxide

How are they generated?
By travelling
By using electricity
By running industries

Reflected sunlight

Absorption by land and water

Leading to

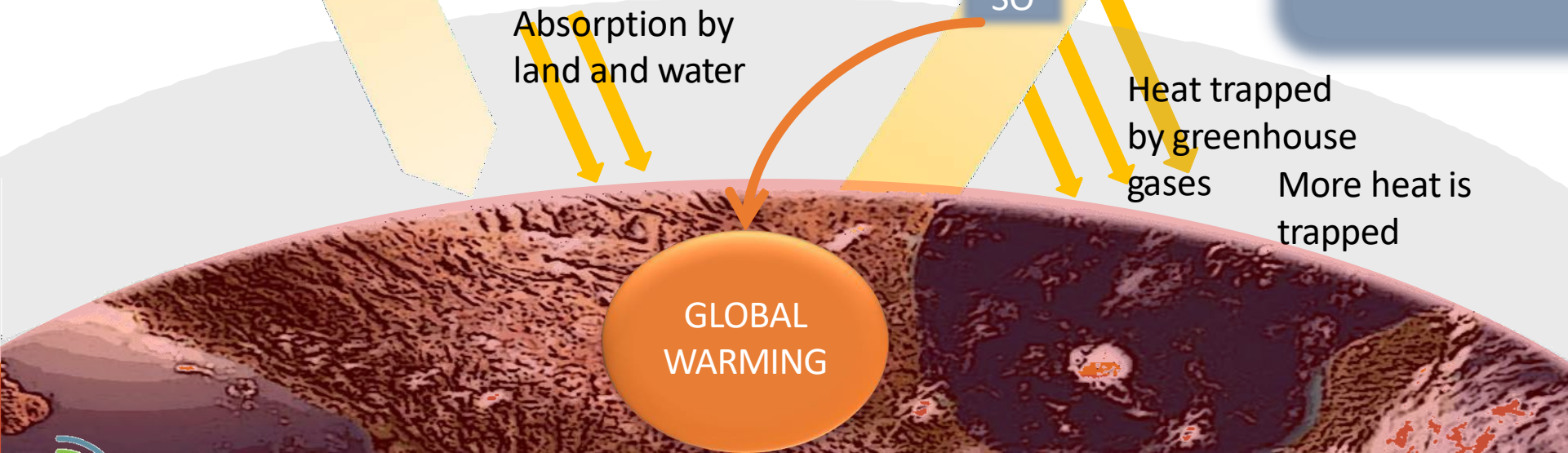
SO

Radiated to space

Heat trapped by greenhouse gases

More heat is trapped

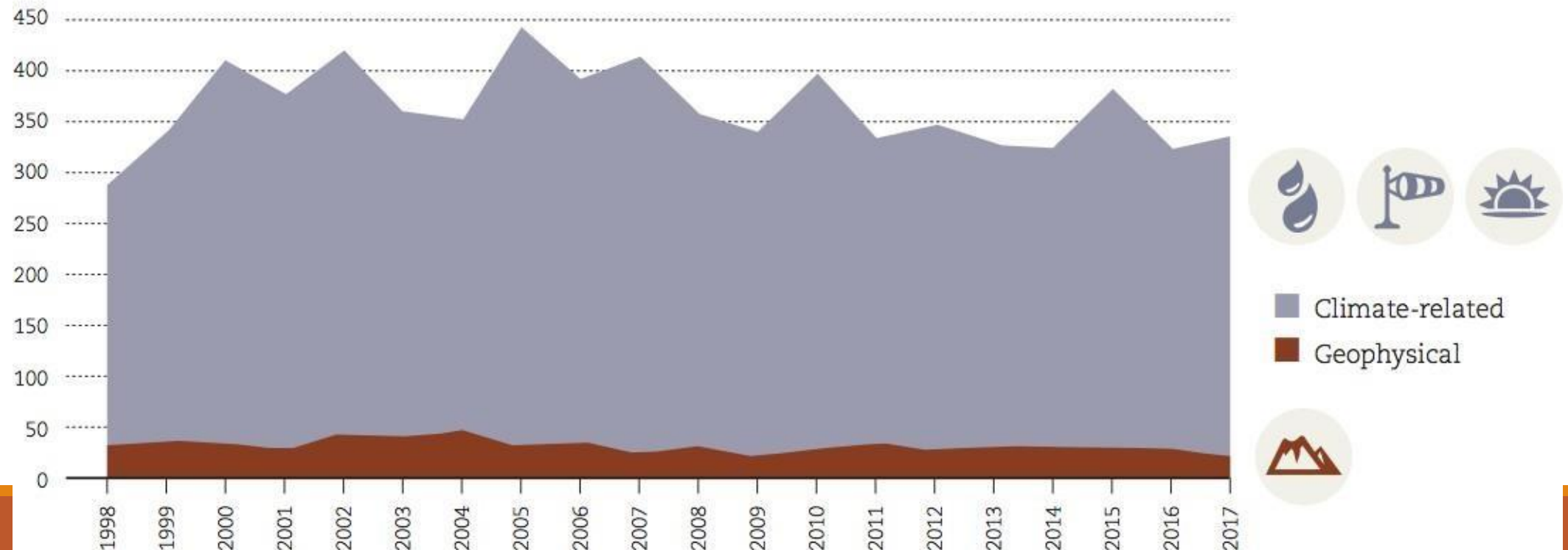
GLOBAL WARMING



Impacts due to Climate Change - Global

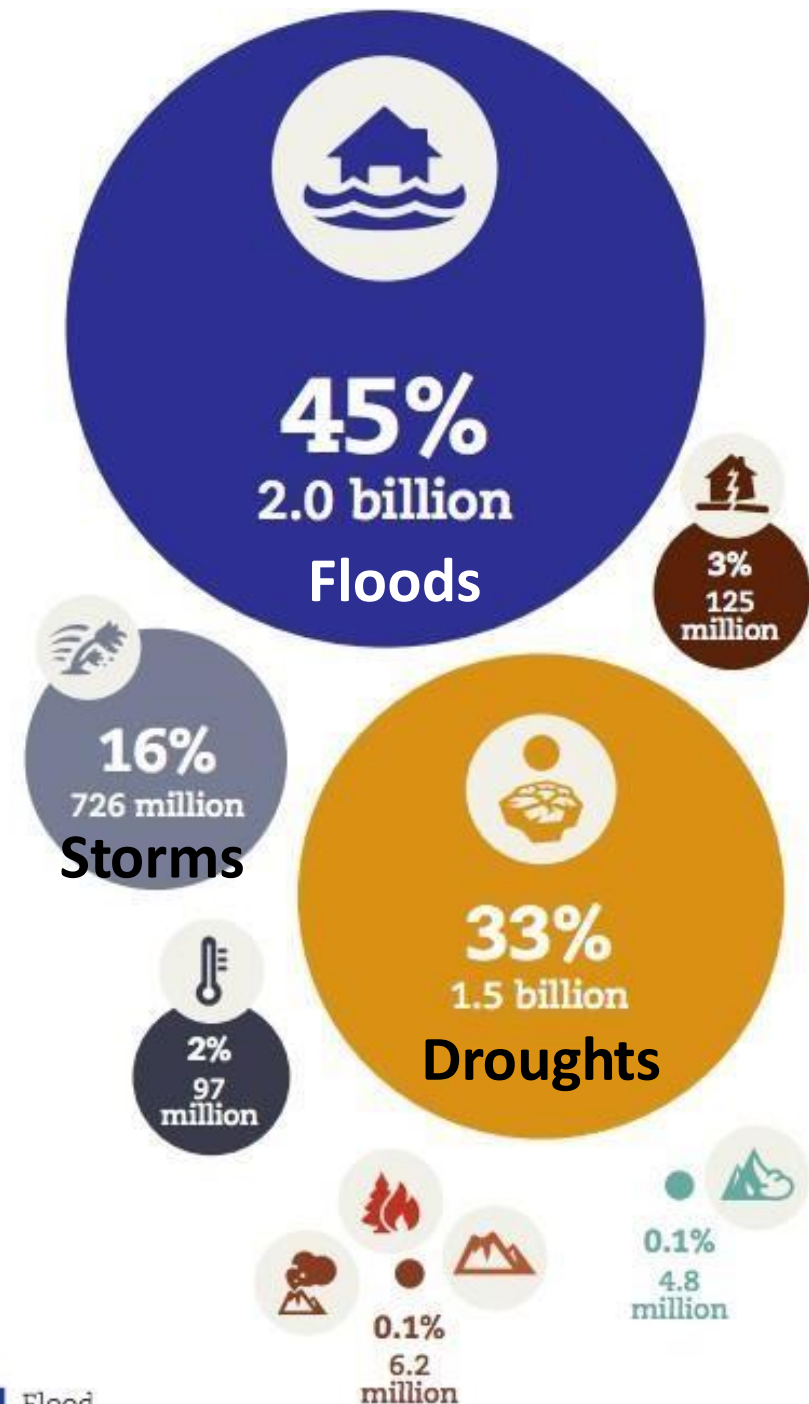
- ▶ At least **90% of all major disasters recorded from 1988 to 2017 were climate-related.**

Number of disasters by major category per year 1998-2017



Impacts due to Climate Change - Global

- ▶ **Floods – affected 2 billion people**
- ▶ **Droughts affected a 1.5 billion people**
- ▶ **Storms were among the most frequently occurring disasters, along with floods.**



Impacts due to Climate Change - India

- ▶ According to UN 2018 report, **India lost \$79.5 billion to climate-related disasters** in the last two decades.
- ▶ **India is among five countries** after the US, China and Japan and Puerto Rico, which have **witnessed the greatest economic losses** due to climate-related disasters.



Impacts due to Climate Change on Railways

► Disruption of Services



**Flooding of tracks in Thiruvananthapuram
(August 2018)**



**1000 passengers rescued
heavy flood near Mumbai (July 2019)**

Impacts due to Climate Change on Railways

► Disruption of Services



Landslide on the railway track on the Karnataka-Goa border (August 2018)



Landslides Halt Train Services In Assam Hill Section (June 2018)

Impacts due to Climate Change on Railways

► Damage to Infrastructure



Damaged railway line in flood-hit Katihar district (August 2017)



Soil bed under the track washed off due to heavy rain in Uttara Kannada (August 2019)

Response to Climate Change

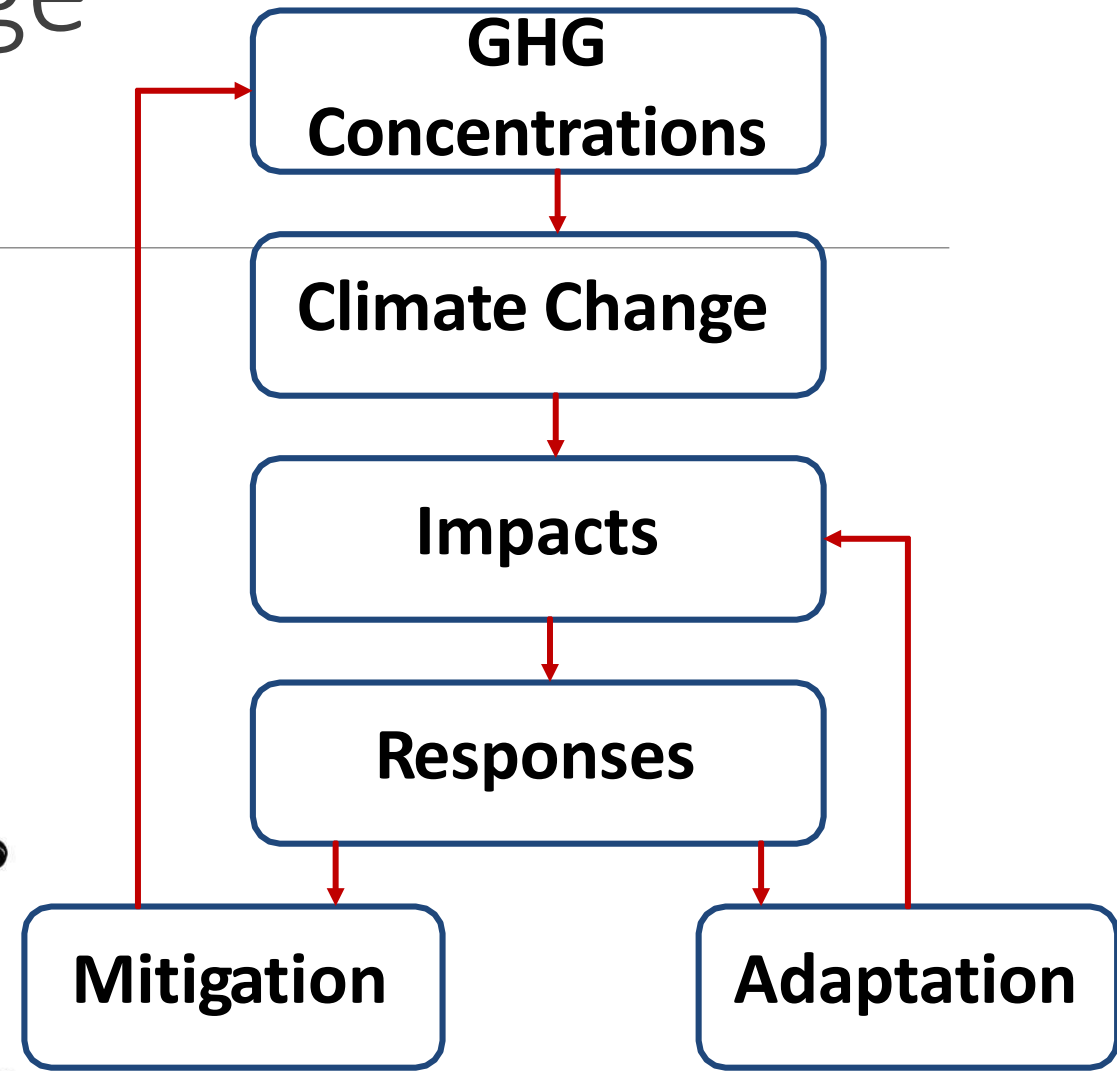
- ▶ **Mitigation** – Mitigate to Prolong or Combat actions to reduce emission of GHG
- ▶ **Adaptation** – Adapt to Survive adjustment in natural or human systems



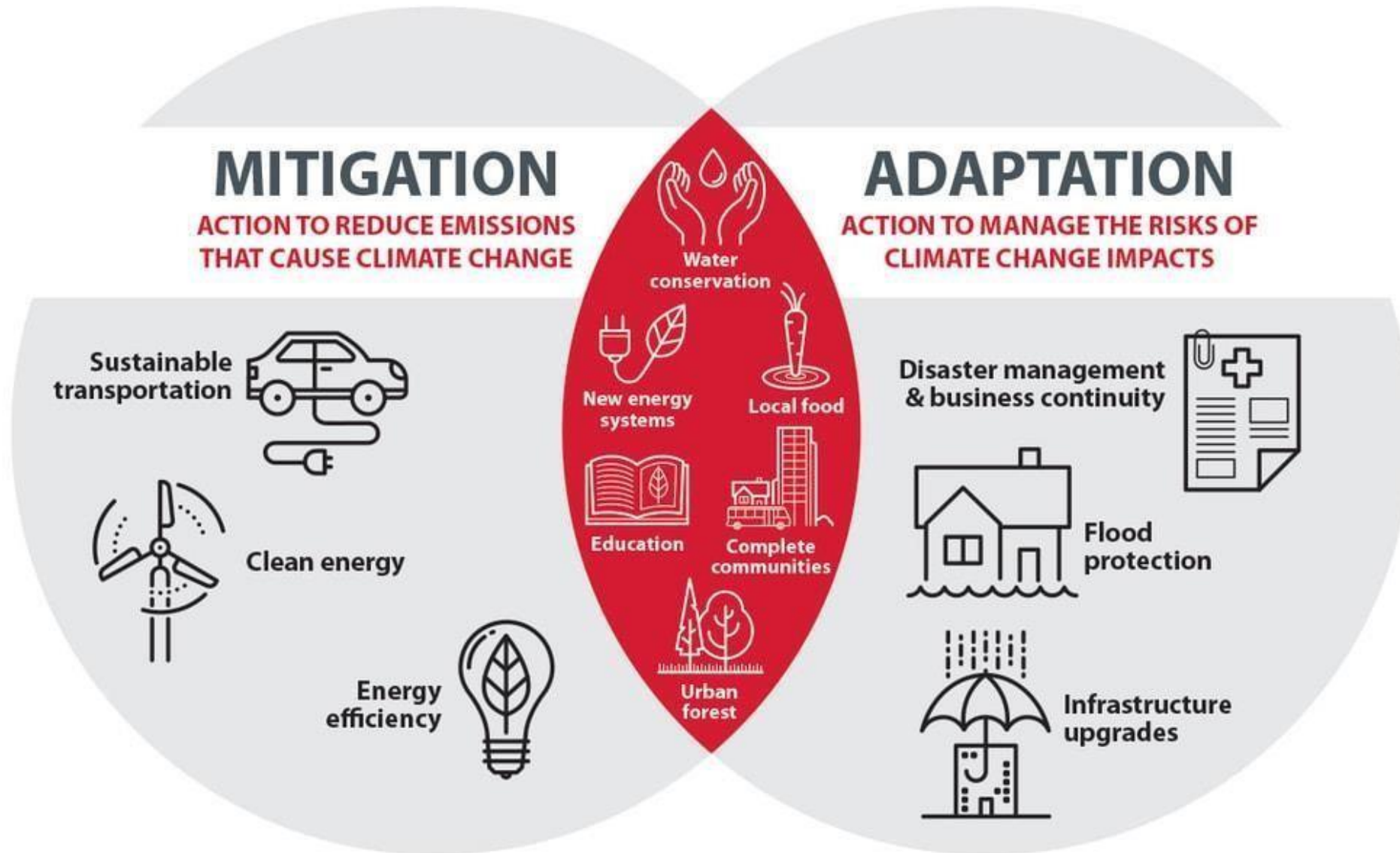
Prevent

mitigate...

.. and adapt!



Response to Climate Change



Breakout room discussion: 15 mins

- List down **3 mitigation** and **3 adaptation** measures currently being taken in IR (based on IR environment sustainability report and your own observation)
- Suggest 1 mitigation/adaptation measure that IR can/must adopt.

Group 1

Group 2

Group 3

Group 4

Group 5

Group 6

Green Initiatives by IR – to Combat Climate Change

Mitigation

ENERGY
(Efficiency,
Conservation)

ALTERNATE FUELS
(Bio-diesel, CNG/LNG,
Eco-friendly options)

GREEN BUILDINGS

SOLID WASTE
MANAGEMENT

Adaptation and Mitigation


ENERGY
(Alternate/Renewable
Sources)

AFFORESTATION

WATER
CONSERVATION

Adaptation Measures

Extreme Precipitation, Flooding



- Design for large drainage capacity to be able to deal with more intense rainfall events
- Audit and maintain drains regularly (especially before the rainy season)
- Enhance pumping to pump out water from tunnels, stations and rails
- Early warning system and evacuation planning for intense rainfall events

Increase in Temperature and Heat Waves



- Installation of green roofs on the stations or can be painted with light/white colour to prevent heat absorption
- Expansion joints can provide space for rail expansion thereby preventing buckling
- Regularly maintenance activities like distressing operations especially during summers

Green Economy for Sustainable Development

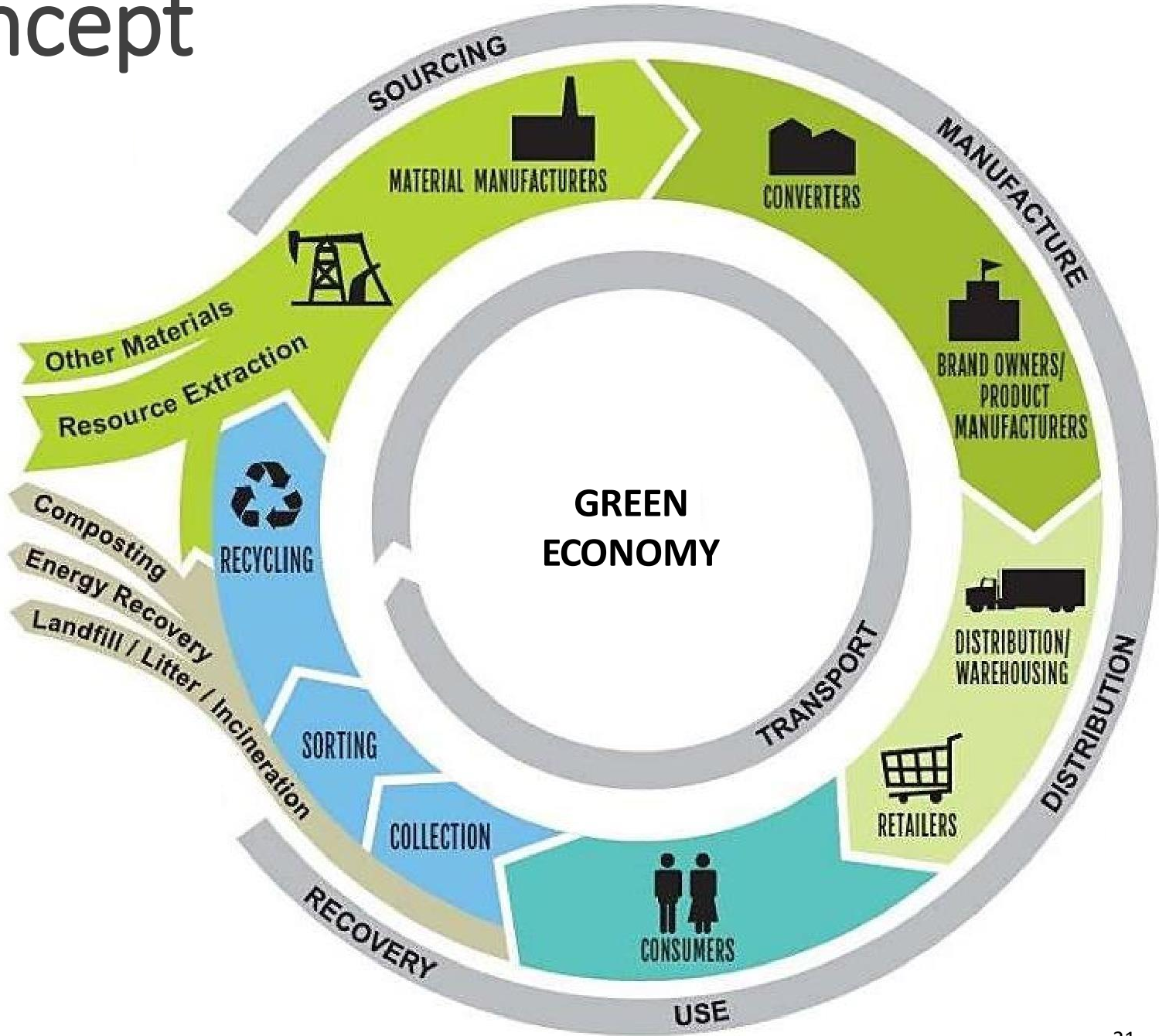
Green Economy Concept

Low Carbon + Resource Efficient + Socially Inclusive

Resource Efficiency
Achieving greater wellbeing whilst reducing resource use and emissions

Green Economy
A macro-economic approach
Focus on investing in green economic activities, infrastructure & skills

Sustainable Consumption & Production
Policies, tools & practices that support a green economy approach
Focus on mainstreaming of eco-efficient production & consumption behaviors

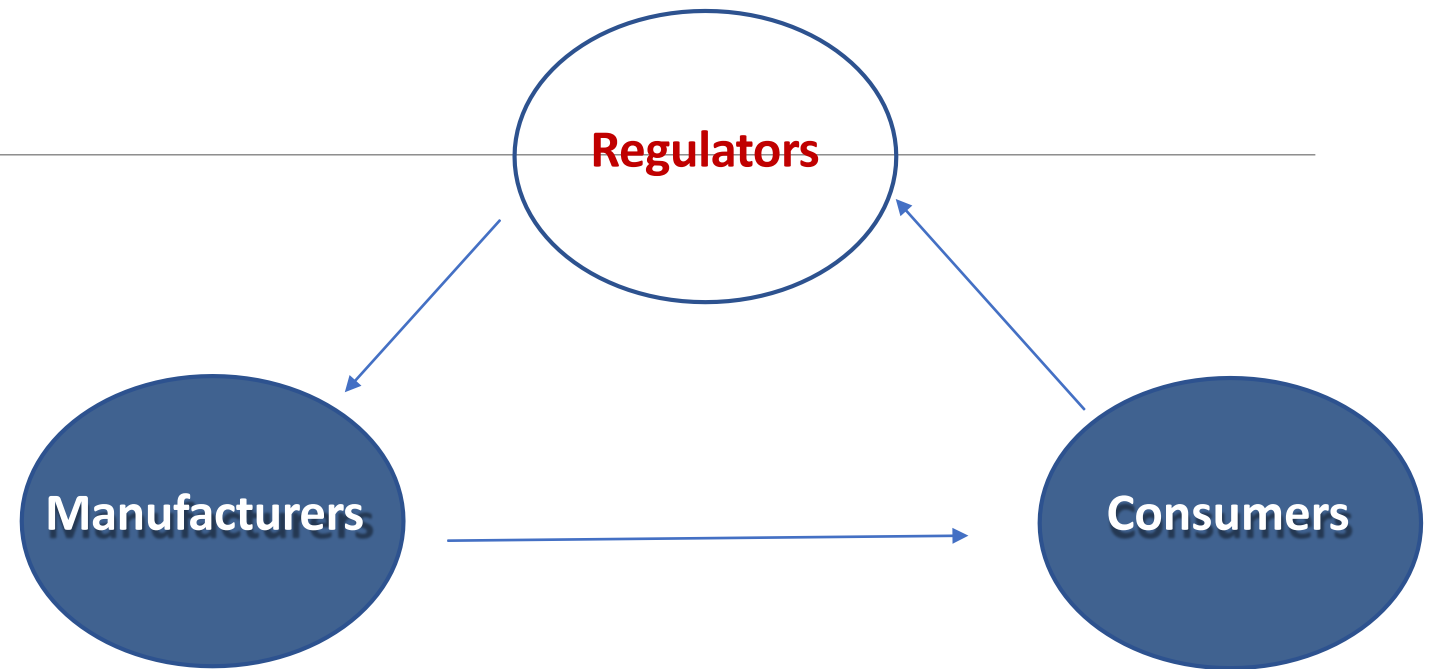


Benefits of Green Economy



Use of Ecolabels

- ▶ An ecolabel identifies products or services proven environmentally preferable overall, within a specific product or service category. Global Ecolabelling Network members operate some of the world's strongest ecolabels



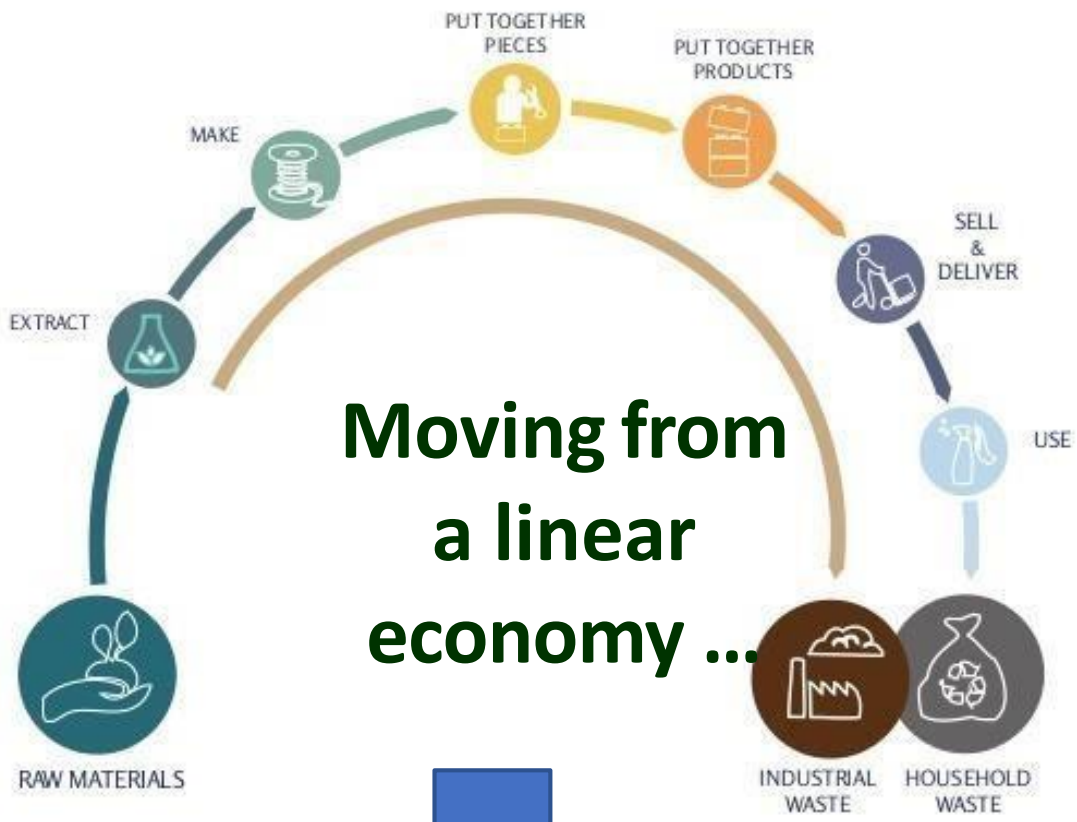
There are 3 main types of ecolabels guided by ISO 14024, ISO 14021 and ISO 14025 respectively.

Other Types of Ecolabels – Energy Star, ISEAL labels etc.

Circular Economy

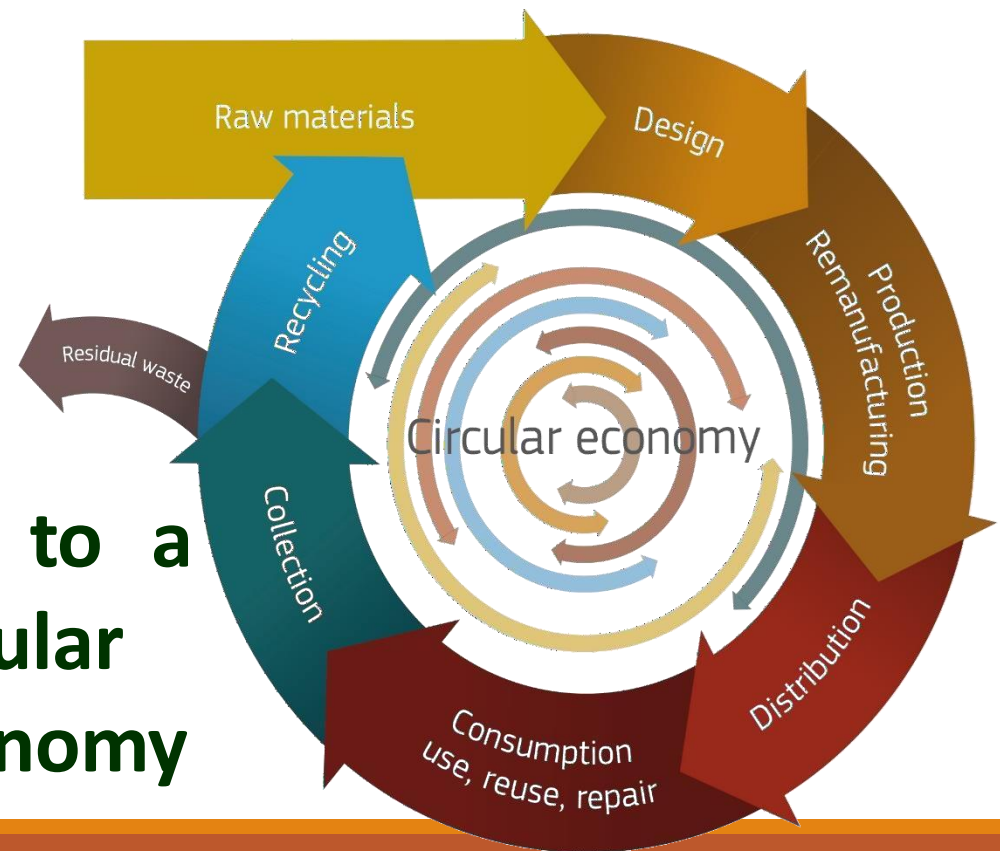
- ▶ Circular Economy aims to '*close the loop*' and design waste out of the system

- Transition from 'take, make, dispose' linear operating model to a more responsible all-encompassing and abundant resource management system
- ▶ Avoiding landfills and incineration altogether and keeping resources in use for as long as possible through reuse and regeneration of new products



**Moving from
a linear
economy ...**

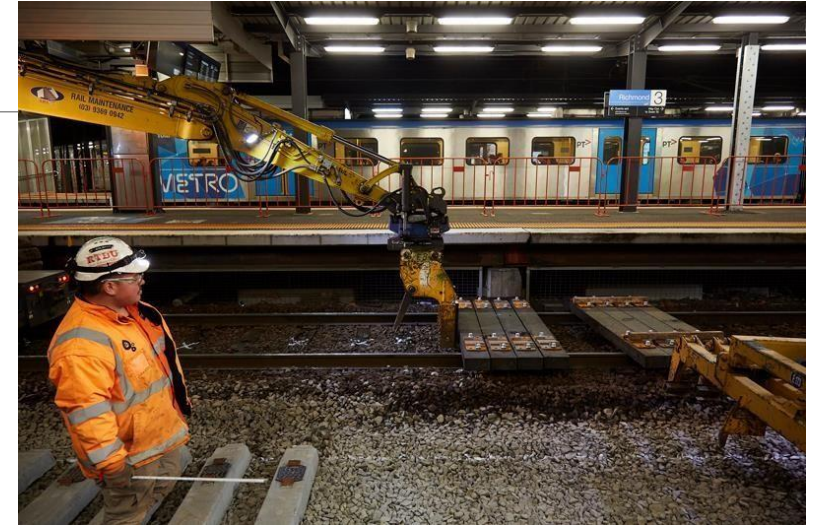
**... to a
circular
economy**



Railway Sleepers made from Recycled Plastic

composite plastic sleepers are produced in Mildura by Integrated Recycling and contain a mix of polystyrene and agricultural plastic waste, including cotton bale wrap, vineyard covers and pipe from the mining industry

- ▶ Sleepers have a lifespan of up to **50 year**
- ▶ At the end of their lifetime the **sleepers are recycled into new sleepers**
- ▶ Plastic sleepers **reduce the need for timber resources, reduce concrete production** and recycle plastic waste
- ▶ For every kilometre of track installed with the sleepers, **64 tonnes of plastic waste that would have otherwise gone to landfill is recycled**



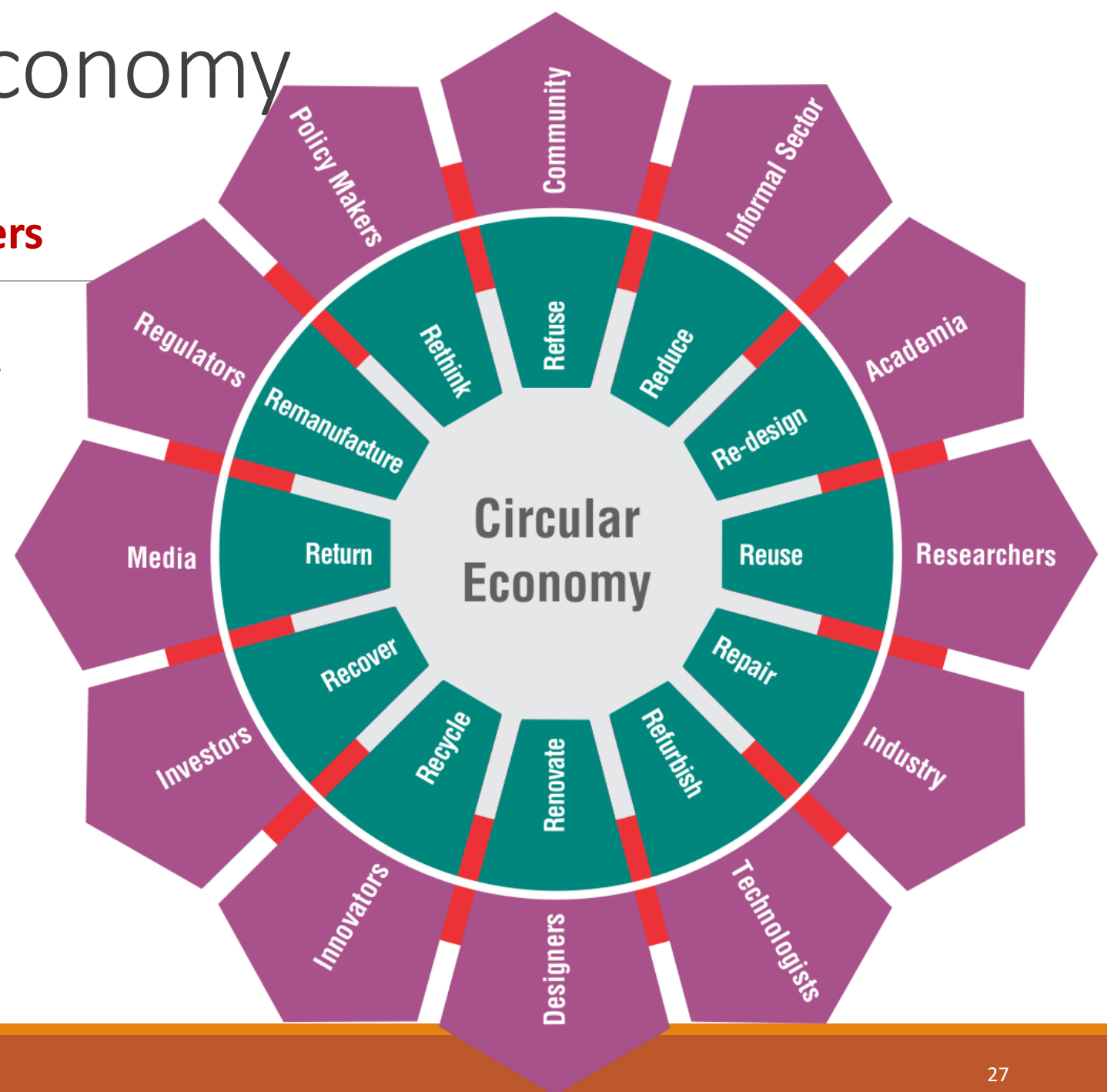
12Rs of Circular Economy

The 12 Rs

- Refuse
- Reduce
- Re-design
- Reuse
- Repair
- Refurbish
- Renovate
- Recycle
- Recover
- Return
- Remanufacture
- Rethink

The Stakeholders

- Community
- Informal Sector
- Academia
- Researchers
- Industry
- Technologists
- Designers
- Innovators
- Investors
- Media
- Regulators
- Policy Makers



Role of Indian Railways in Sustainable Development

Vision

To promote Green environment and clean energy while making the Indian Railways a global leader in sustainable mass transport solutions.

Sustainability Initiatives Taken by Indian Railways

- Energy & sustainability, Technology Upgradation are among the eleven major thrust areas of Action Plan (2015-19), Railway Budget 2015-16.
- **An area of 41,417 hectares of railway land is under afforestation.**
- Railways have planted around 1.1 crore saplings during the year 2018-19.



Role of Indian Railways in Sustainable Development

Energy Efficient Strategies of Railways

- Debottlenecking the existing network
- Strengthening the existing network
- Augmentation of network
- Energy efficient operation
- Using renewable & alternate sources of energy

Indian Railways' Solar Mission is part of National Solar Mission

Target – 1000 MW of solar power across Indian Railways' network by 2020-21

- ❖ 12,755 coaches were provided with LED lights from 2014-15 to 2017-18 and 7,755 more coaches have been provided with LED lights during 2018-19
- ❖ Indian Railways has installed 82.42 MW Solar and 53 MW Wind power across Railway installations. Plan to install 200 MW wind power by 2020-21



Trains powered by solar panel



Asangaon Railway station of Central Railway under Mumbai Division has been declared 100% Green Powered Station in March, 2018 as it is powered with windmill and solarpanels

Use of Alternative Fuel

- Indian Railways started 5% Bio-Diesel blending with High Speed Diesel (HSD) since 5th June 2015.
- Blending of bio-diesel to the extent of 5% was initiated at 76 RCDs of Indian Railways in different Zones.

Water Conservation Strategies

- Indian Railways water policy formulated in **2017**
- **Rainwater harvesting** mandatory on roofs larger than 200 sq. meter
- Water conservation may also be done by **reviving old water bodies on railway land**
- Mandatory adoption of small vegetated infiltration basins for **storm water management**
- Effluents generated at railway stations **should be discharged into ETP/STP** to be located near major railway stations
- There are **Automatic Coach Washing Plants** being installed.



Water recycling plant at Indian Railways Coaching Depot



12 Automatic Coach Washing Plants have been installed in 2018-19

Other Sustainable Initiatives

- Development of **composite sleepers made of a polymer matrix, typically polyethylene (HDPE), with reinforcing fibres** is being done as an alternative to wooden sleepers.
- Use of **Common Rail Direct Injection (CRDI)** as fuel injection system leads to reduction in fuel consumption, reduction of emissions to very low levels and reduction of engine combustion generated noise
- **New Delhi station** became the first railway station in the country to have a **Waste to Energy plant** within its premises in June 2016
- More than 195,900 **bio-toilets** have been installed in nearly 53,900 coaches till March 2019
- During the year 2018-19, ICF has provided **bio-vacuum toilets** in 230 AC coaches, MCF has provided in 24 coaches and RCF in 92 coaches
- 11 **plastic bottle crusher machines** were provided by March 2019, more in progress.



Bio-vacuum toilet in train



Plastic bottle shredding machine in railway station

IR's Interventions towards SPP: Use of Compostable Plates

- ▶ Passengers are served meals in compostable plates and bowls in place of polymer ones
- ▶ **Supplier** – Yash Papers based in Faridabad
- ▶ **Brand Name** – CHUK
- ▶ **Introduced in** – 2018
- ▶ **Trains in which introduced** – Various Shatabdi, Duronto and Rajdhani trains
- ▶ **Product details** –
 - ▶ Sugarcane fiber is used. Completely chemical free
 - ▶ Lightweight, flexible and leak proof
 - ▶ Decomposes in 60-90 days after being disposed

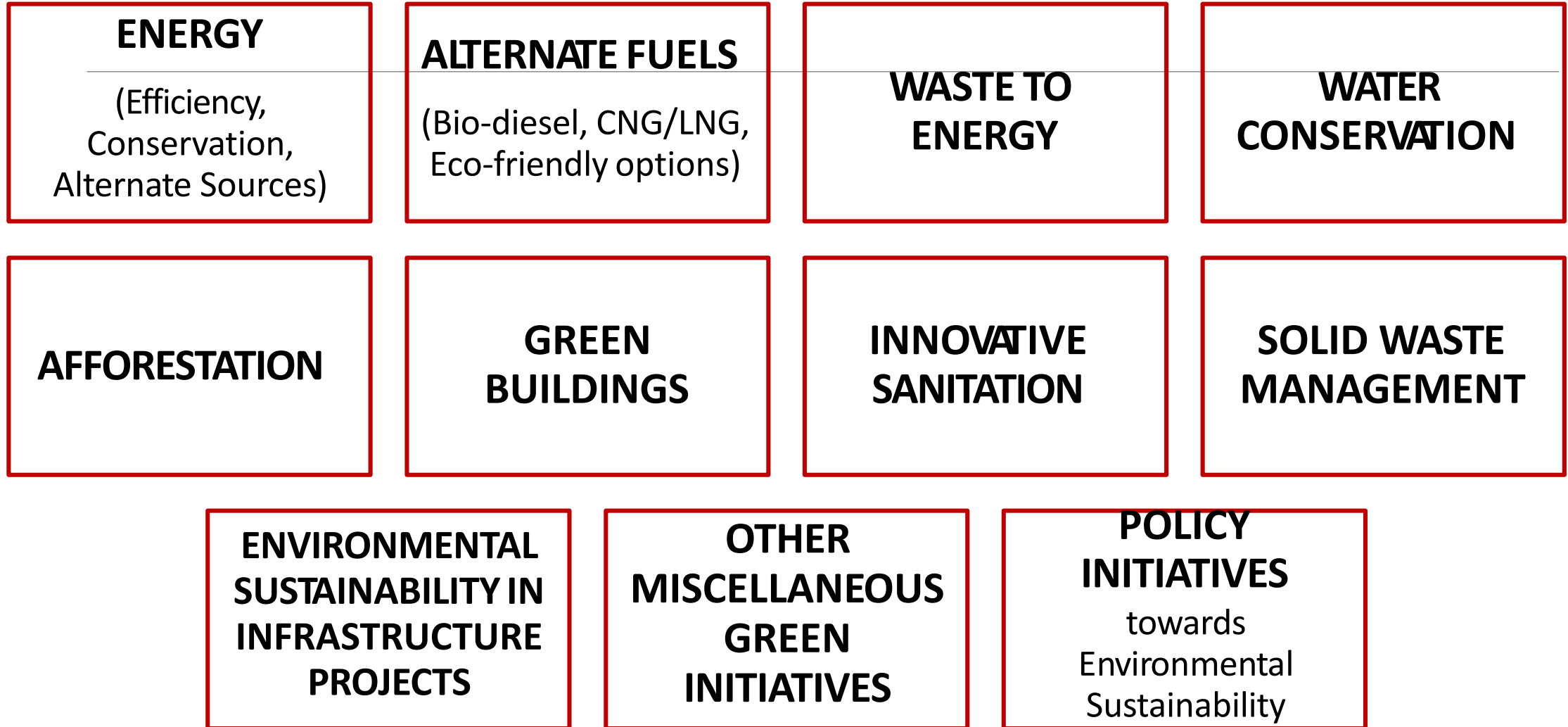


Indian Railway's Vision 2020 (set in 2009)

Environmental Sustainability Goals

- ▶ Carbon Mitigation and Carbon Credits
- ▶ Utilize at least 10% of its energy requirement from renewable sources
- ▶ Institute a fool proof eco-friendly waste management system
- ▶ Undertake a massive plantation drive along the Railway tracks and in railway colonies
- ▶ Use grass-turfing as a protective anti-erosion measure on the slopes of the banks along the track

Overview of Green Initiatives at IR



Green Buildings and Certifications



Potential for Green Infrastructure in Indian Railways

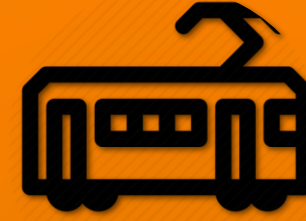
Green infrastructure - solving urban and climatic challenges by building with nature



Green
Workshops
and
Factories



Green
Railway
Stations



Green Train
Coaches



Green
Offices



Green Rating Agencies



The U.S. Green Building Council



Green Co Rating System



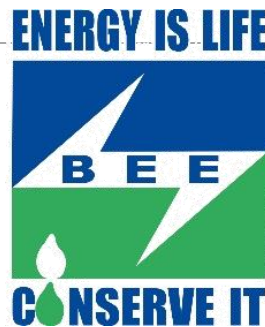
Green Rating for Integrated Habitat Assessment



The Indian Green Building Council

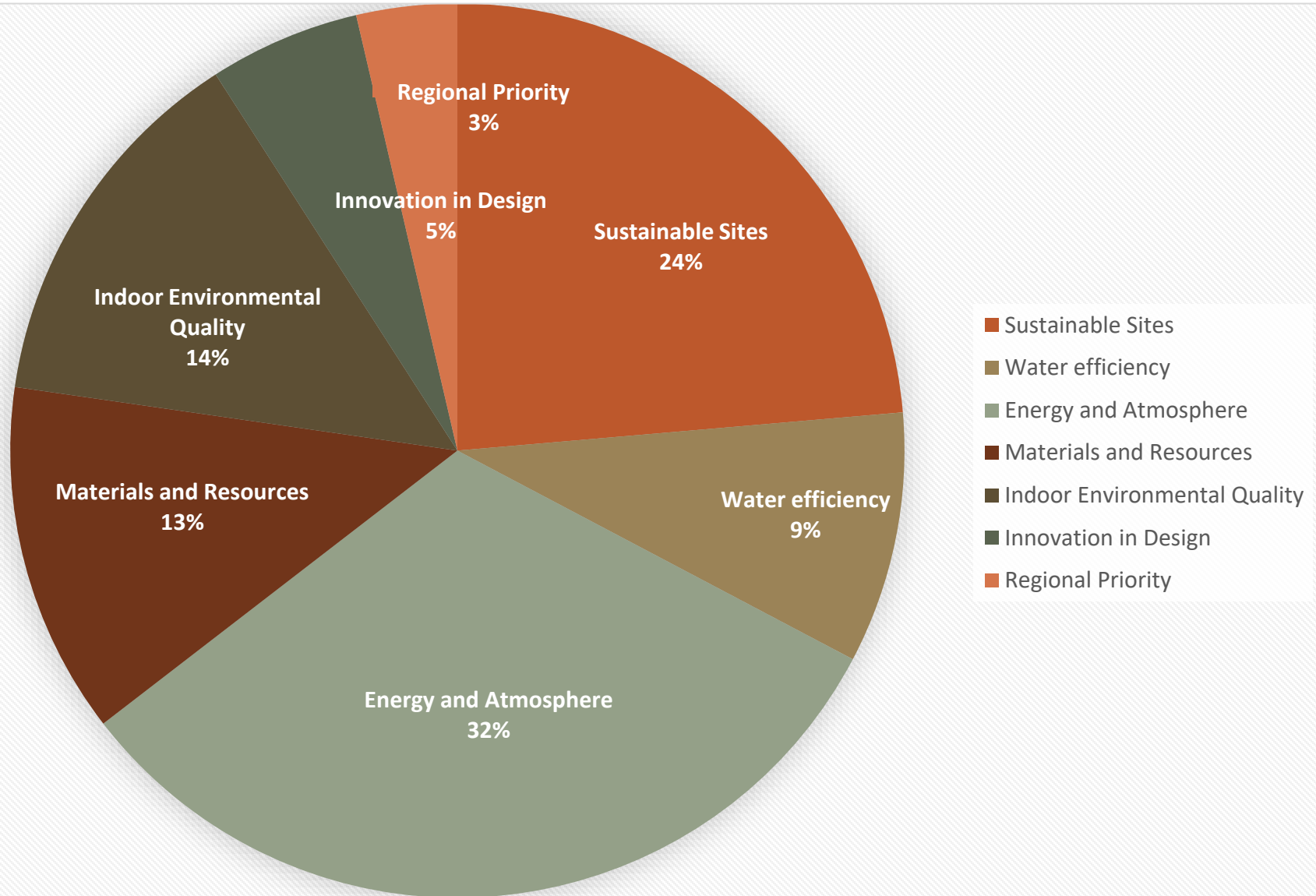


Green Habitat Accomplished Rating



BEE certification

Criteria and Weights



Detailed Criteria for IGBC Certification

Mandatory

Not Mandatory

Sustainable Sites

Developing on appropriate sites

Community Connectivity / Basic Amenities

Design for differently-abled

Alternative means for transportation

Protect or Restore Natural topography

Heat island effect

Night Sky Pollution reduction

Soil Erosion Prevention and Control

Compliance to Local Regulations



Water Conservation

Low Flow Fixtures

Rainwater Harvesting

Treatment of Grey water

Use of captured or treated water

Efficient Irrigation systems

Use of native and adaptive species

Reduce turf area



Energy Conservation

Refrigerants - No CFC

Building Envelope measures

Selection of energy efficient equipment

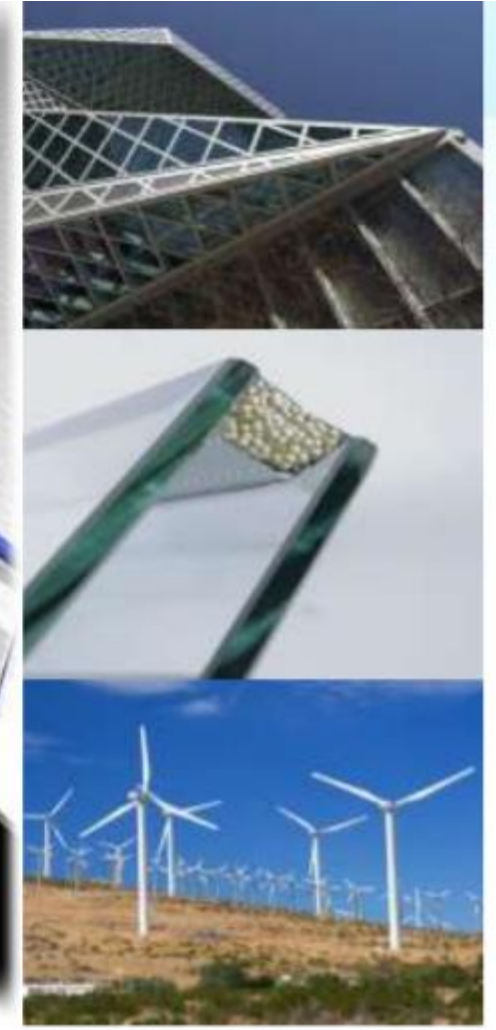
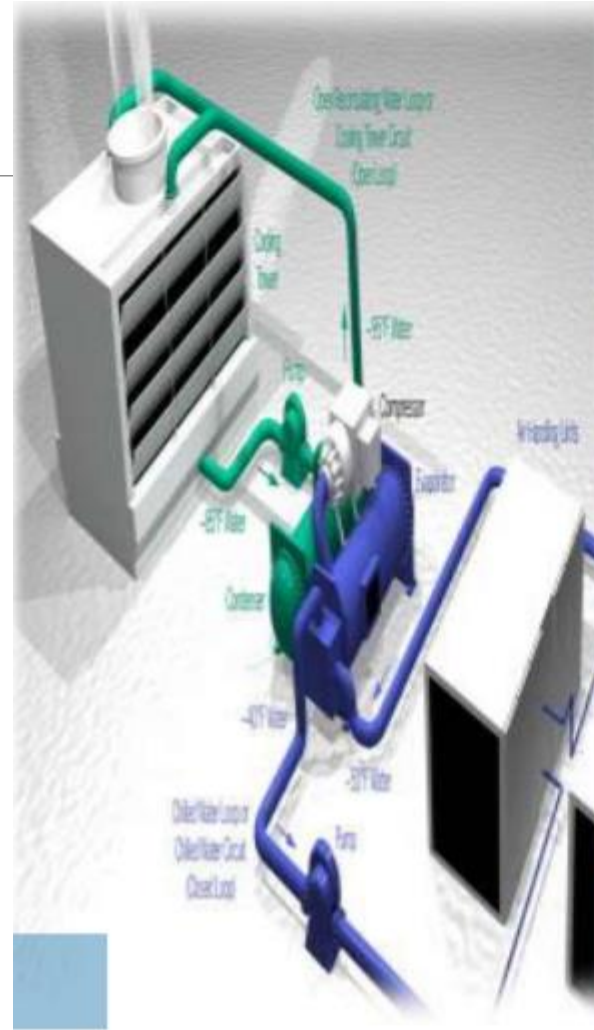
Building Energy Performance

Renewable energy

Green Power

Energy efficient Lighting

Eco-friendly captive power generation



Materials

Waste Segregation: non-process

Construction waste management

Recycled Materials

Reused Materials

Local Materials

Certified wood

Renewable Materials



Indoor Air Quality

Tobacco smoke control

Daylight and Views

Avoid asbestos

Fresh air ventilation

Low VOC content

Building flush out

Eco-friendly house-keeping

Break-out spaces for employees



IGBC Certification Levels



Thank you



Green Initiatives at ICF Chennai - Renewable Energy



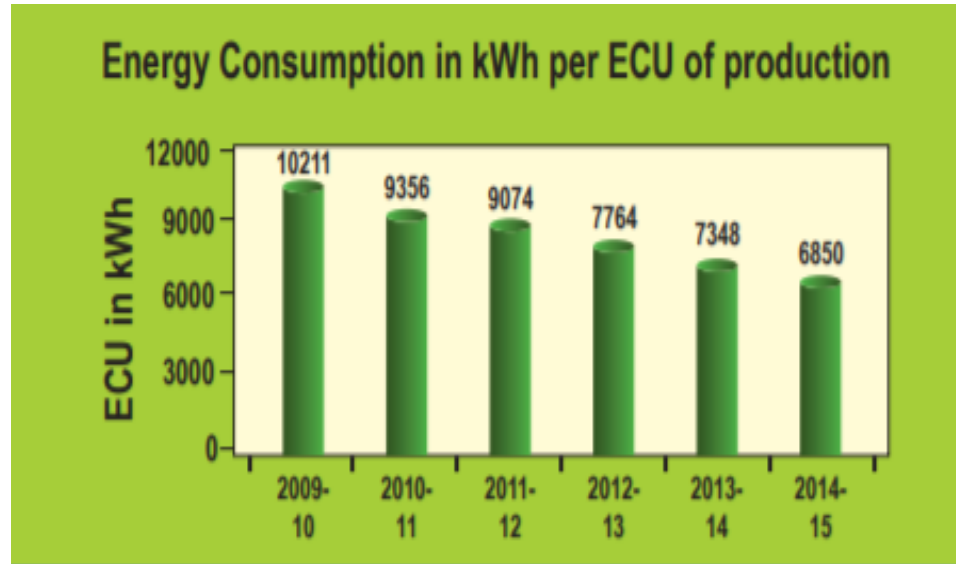
Solar water heaters having total installed capacity of 3000 LPD have been provided in Officers and Subordinate Rest Houses, Apprentices Hostel, ICF Hospital.

ICF has reduced CO₂ emissions to the extent of 60242 ton from 2009 to 2015.



ICF entirely sources its electrical energy requirement from 7 windmills of 1.5 MVA capacity each in the Tirunelveli.

Green Initiatives at ICF Chennai



Energy Conservation Measures: Energy required for manufacture of coach has declined from about 10,211 units in 2009-10 to 6,850 units in 2014-15.

Smart technology enabled energy conservation measures have been implemented across factories.



Energy Conservation measures at ICF Chennai

Device	Function
Occupancy Sensors	<ul style="list-style-type: none">• Sense human movement and switch off automatically the Air-Conditioners and room lights when there is no human movement
Automatic Power Factor Correction Panels	<ul style="list-style-type: none">• Power factor values are monitored and controlled more precisely.• All 32 substations of ICF have been provided with APFCP and a high power factor of 0.99 has been achieved
Use of timer switches to control lighting circuits /air circulators	<ul style="list-style-type: none">• Switch off non-essential lights during night time.• Air-circulators are controlled by timer circuits to automatically switch off during non-working hours.

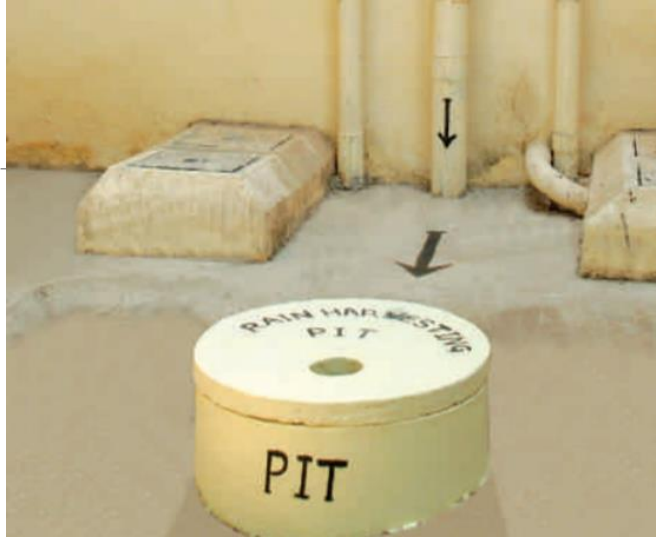
Energy Conservation measures at ICF Chennai

Device	Function
Energy Savers	<ul style="list-style-type: none">• Switch OFF Arc welding machines when they are not in use for more than 3 minutes.
Energy Efficiency in Compressed air system and Pumps	<ul style="list-style-type: none">• Adjusting the ON/OFF time of air compressors and arresting the leakages in the pipeline.• Energy efficient submersible pumps have been provided replacing old centrifugal pumps.
Star Rated Equipment	<ul style="list-style-type: none">• BEE approved star rated electrical products such as ceiling fans, air-conditioners, geysers, refrigerators, water coolers etc.

Energy Conservation measures at ICF Chennai

Device	Function
Turbine air ventilators in place of roof exhaust fans	<ul style="list-style-type: none">• Operate on natural draft without electrical power installed to exhaust hot gases emanating from welding operation, furnace etc.
Energy Efficient Lighting	<ul style="list-style-type: none">• Replacing old lamps with latest energy efficient lamps.• All pathway lights in the factory area have been provided with induction lamps and all major streets in the colony area have been provided with LED lamps, duly replacing metal halide lamps.
Use of Natural lighting in workshops and office buildings	<ul style="list-style-type: none">• Polycarbonate sheets have been provided extensively on the roof to provide excellent diffused sunlight during day

Green Initiatives at ICF Chennai – Rain Water Harvesting



In Railway Colonies, every block has been provided with pipelines to carry water collected on the roof top to percolation pits.

Two percolation pits are provided for every block for recharging the ground water.

Water from the Reservoir is treated and supplied to both Shell and Furnishing factories meeting the entire requirement of the factories, except for drinking water purpose.

Reduction of 15.57% of water usage has been achieved as per Water Audit, 2015.

Green Coaches for Indian Railways – Solar Roof Tops



450 DEMU trailer coaches are being installed with flexible solar panels based on Li-ion battery.

500 passenger trains with existing batteries installed with flexible solar panels.

The flexible solar panels can be easily installed on train coaches and are 80 per cent lighter than conventional solar modules.

Green Coaches for Indian Railways – Solar Roof Tops



Bio-discharge toilets have underslung tanks to collect human waste and degrade it by a special type of bacteria.

Converts human waste into gas and discharged harmlessly into atmosphere.

SMALL CHANGE, BIG GAIN

How the modified bio-toilet of a railway coach works

WHAT'S NEW

At present, digested waste after chlorination is discharged onto railway tracks in liquid form

Odour and colour removing agents are added before it is used as flushing liquid

In new system, the discharge (before chlorination) will be used to flush toilets

ADVANTAGES

Reduce amount of the water used for flushing

A study by mechanical department shows that **600 litres** of water per day per coach can be saved



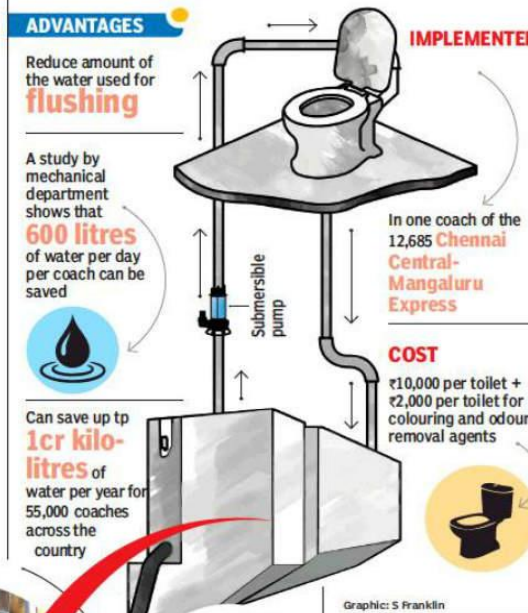
Can save up to **1 cr kilo-litres** of water per year for 55,000 coaches across the country

IMPLEMENTED

In one coach of the 12,685 **Chennai Central-Mangaluru Express**

COST

₹10,000 per toilet + ₹2,000 per toilet for colouring and odour removal agents



NEW SETUP: The bio-toilet tank from where digested waste and water will be sent to the added chamber

Graphic: S Franklin

RAILWAY SOURCES SAID THEY HAVE NOT RECEIVED ANY NEGATIVE FEEDBACK FROM PASSENGERS ON THE MODIFIED BIO-TOILET THAT IS UNDER TRIAL ON THE MANGALURU EXPRESS

Green Coaches for Indian Railways – CNG DEMU



CNG DEMU manufactured at ICF has the mechanism to run on dual fuel using the CNG as an alternate fuel to diesel.

25 Diesel Power Cars of DEMUs have been converted into CNG based dual fuel engine.

Green Coaches for Indian Railways – HOG System



In EOG configuration, power cars provided at both ends to cater to lighting and HVAC load in trains.

All EOG trains are being converted to HOG, a total net saving of Rs 313.8 crores per annum has been achieved by way of reduction in diesel consumption.

Green coaches for Indian Railways – Green Interiors

Energy efficient lighting in coaches



- LED lights are being provided in coaches for night light fittings, toilet light fittings, passenger alarm, berth indication and accident emergency light fittings.
- Incandescent lamps have been totally replaced with energy efficient fluorescent lights and CFL lights.
- Glass Roofs have been provided for entry of natural daylight and energy savings

Green coaches for Indian Railways – Green Interiors

Eco-friendly refrigerant in AC coaches



- All new AC coaches are now being manufactured with R-407C refrigerant, which have no chlorine atoms to affect the ozone layer.

Green Coaches for Indian Railways – Green Interiors

Use of eco-friendly materials in coaches



- Use of natural fiber thermoset composite (NFTC) material to replace compreg wood for flooring in the coach.
- Use of polycarbonate seats in place of wooden seats.
- Use of water-based paints, which are more eco-friendly, as a trial measure, in place of solvent paints.
- Use of aluminum composite interiors, which are recyclable, replacing laminated plastic sheets.

Green Coaches for Indian Railways – Green Interiors

Energy Efficient fans



- Conventional DC fans with commutator and carbon brushes which require regular maintenance are being replaced with brushless DC fans.
- Conventional DC fans consume about 38W power while brushless DC fans (BLDC) which consume only 25W power.
- Besides being energy efficient, the brushless fans also require less maintenance.

IGBC Green Railway Stations

CII-IGBC with the support of Environment Directorate of Indian Railway has developed the Green Railway Stations rating system. It is a voluntary and consensus-based program.

Facilitate adoption of green concepts, thereby reduce the adverse environmental impacts due to station operation & maintenance and enhance the overall commuter experience at station.

Designed to help the station management to understand their present position with respect to the '*green performance*' of the station and the measures that need to be taken to enhance the performance on a continual basis.

Case Study: Secunderabad Railway Station



Achievements at a Glance

- First Platinum Rated Station in India.
- ISO 14001-2015 Certificate- Environmental Management system.
- National Tourism Award 2016-2017

Source:

<https://www.financialexpress.com/infrastructure/railways/indian-railways-secunderabad-station-is-1st-to-achieve-igbc-green-platinum-rating-details-pictures-here/1709849/>

Green Railway Stations – In the News

Sec'bad is India's first green station

BUSINESS BUREAU
Hyderabad

Secunderabad Railway Station (South Central Railway) has received CII-IGBC (Indian Green Building Council) Platinum rating. The Station gains the unique distinction of becoming India's first platinum rated green railway station. The award was given under IGBC Green Railway Stations Rating System.

Piyush Goyal, Minister for Railways, C Shekar Reddy, chairman, IGBC Hyderabad Chapter presented IGBC plaque and certificate to Vinod Kumar Yadav, GM, SCR at a programme organised at Secunderabad Railway Station on Friday.

Green Railway Stations rating is a tool to facilitate adoption of green concepts, thereby reduce the adverse environmental impacts due to station's operation and



BEST PRACTICES: Union Minister Piyush Goyal presenting IGBC plaque and certificate to SCR GM Vinod Kumar Yadav.

maintenance. The overarching principle of the rating is to enhance commuter's experience. The rating system facilitates- energy efficiency improvements; use of renewable energy sources; water management and rain water harvesting; health, hygiene and sanitation; green cover and providing universal access.

Some of the green fea-

tures implemented at station include-100 per cent LED lit railway station, more than 80 per cent spaces with adequate fresh air ventilation, 500 kWp grid connected solar PVs installed at station rooftop, 100 per cent waste water from station and coaching yard is treated and recycled for coach washing and others.

(SEE PAGE 2)

Skywalk to link Metro station

HYDERABAD: Union Minister for Railways Piyush Goyal on Friday said a skywalk would be constructed from Secunderabad Railway Station to link it with the upcoming Hyderabad Metro Rail Station abutting the premises, apart from assuring land for a multilevel car parking facility near the Ganesh temple.

The skywalk would enable Metro passengers to directly reach the station, he said, after launching a series of passenger amenities at the Secunderabad Railway Station here on Friday.

(SEE PAGES 2,3)

Green Building certification for Central railway station in Chennai

A mime show by scouts and guides was organised as part of the awareness campaign.



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