

Riding the Wave of the Mobility Future

CLEAN FUELS



We have alternative fuels, but we don't have alternate future.



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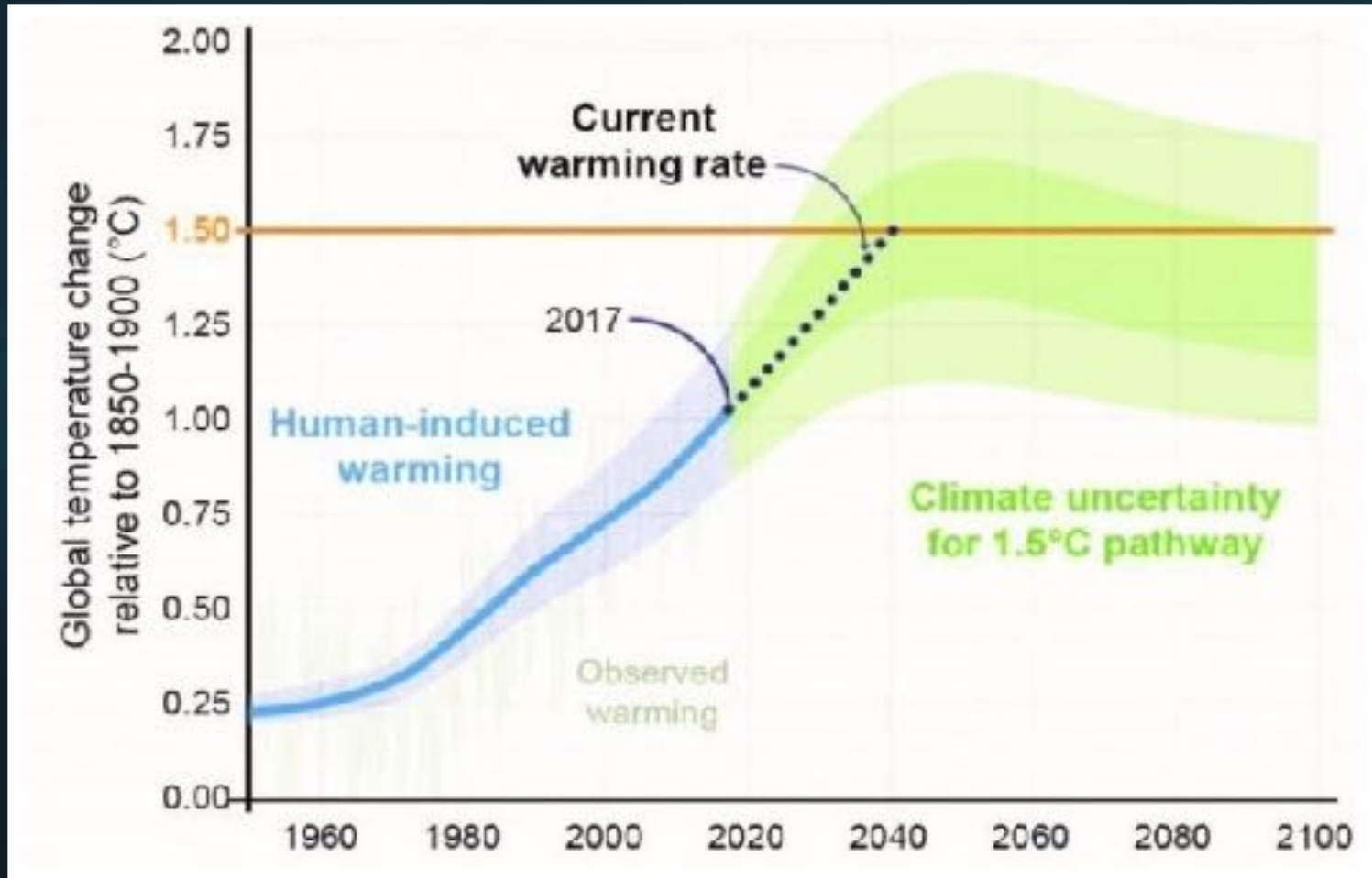
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COP26 OUTCOME:

- CHANGE THE WAY WE MOVE BEGINS WITH THE CHANGING WAY WE THINK, DESIGN & FINANCE OUR MOBILITY SYSTEMS.
- WE CANNOT TACKLE THE CLIMATE CRISIS WITHOUT RETHINKING MOBILITY
- IF WE DON'T ADDRESS THE CLIMATE CHANGE, IT WILL AFFECT OUR GROWTH, OUR DEVELOPMENT & PRODUCTIVITY.
- THE END OF IC ENGINES CANNOT AND SHOULD NOT BE TABOO ANYMORE IN OUR SOCIETY, SUITABLE ACTIONS SHOULD BE TAKEN
- ADAPTING EV VEHICLES ALONE IS NOT ENOUGH. WE MUST CHANGE HOW WE MOVE, AND BETTER PUBLIC TRANSPORTATION IS ESSENTIAL
- 2W/3W/4W's ALL MUST GO ELECTRIC IN THE NEXT 4 TO 5 YEARS.
- LONG DISTANCE TRANSPORT SHOULD ALL MOVE TOWARDS GREEN H₂.
- THERE IS ALWAYS SOME MONEY FOR TRANSPORT, BUT THE QUESTION IS WHERE IS THE MONEY GOING TO GO.
- REDIRECTING INVESTMENT WILL BE IN CRITICAL IN ORDER TO SHIFT MOVEMENT AWAY FROM CARS & TRUCKS AND TOWARDS PUBLIC TRANSPORT, ACTIVE MOBILITY, AND OTHER MODES THAT ARE CLEANER AND INCLUSIVE
- WE NEED TO HAVE INVESTMENT STRATEGIES THAT ARE INCLUSIVE AND DECARBONISED FROM THE START

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CLIMATE CHANGE



NOTE : The average surface temperature on Earth is approximately 59° degrees Fahrenheit (15° degrees Celsius), according to NASA

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GOAL NO.7:AFFORDABLE AND CLEAN ENERGY

Ensure access to Affordable, Reliable, Sustainable & modern energy

S#	TARGETS	INDICATORS
1	7.2	7.1.2
	By 2030, increase substantially the share of renewable energy in the global energy mix	Proportion of population with primary reliance on clean fuels and technology
		7.2.1
		Renewable energy share in the total final energy consumption
2	7.3	7.3.1
	By 2030, double the global rate of improvement in energy efficiency	Energy intensity measured in terms of primary energy and GDP

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PROBLEM STATEMENT : CLEAN ENERGY

High Diesel Expenditure leads to go for Alternate Fuels

EPKM = Rs 30 /- (Approximate) , KMPL	= 4.5 (Approximate)
Total earning for 4.5	= Rs 30 x 4.5 = 135/-
One Litre Diesel Cost	= Rs 94.39 = 94.39/-
Diesel Expenses Related to earning (without Subsidiary)	= 94.39/135 = 69.90% = 70% (Approx)
Diesel Expenses Related to earning (with Subsidiary)	= 66/135 = 48.88% = 50% (Approx)
Diesel Expenses per kilometre	= 94.39/4.5 = 20.97 = Rs 21/-

Total earning Rs 30, Diesel Cost =Rs 21, Rs 9/- only for other expenses.

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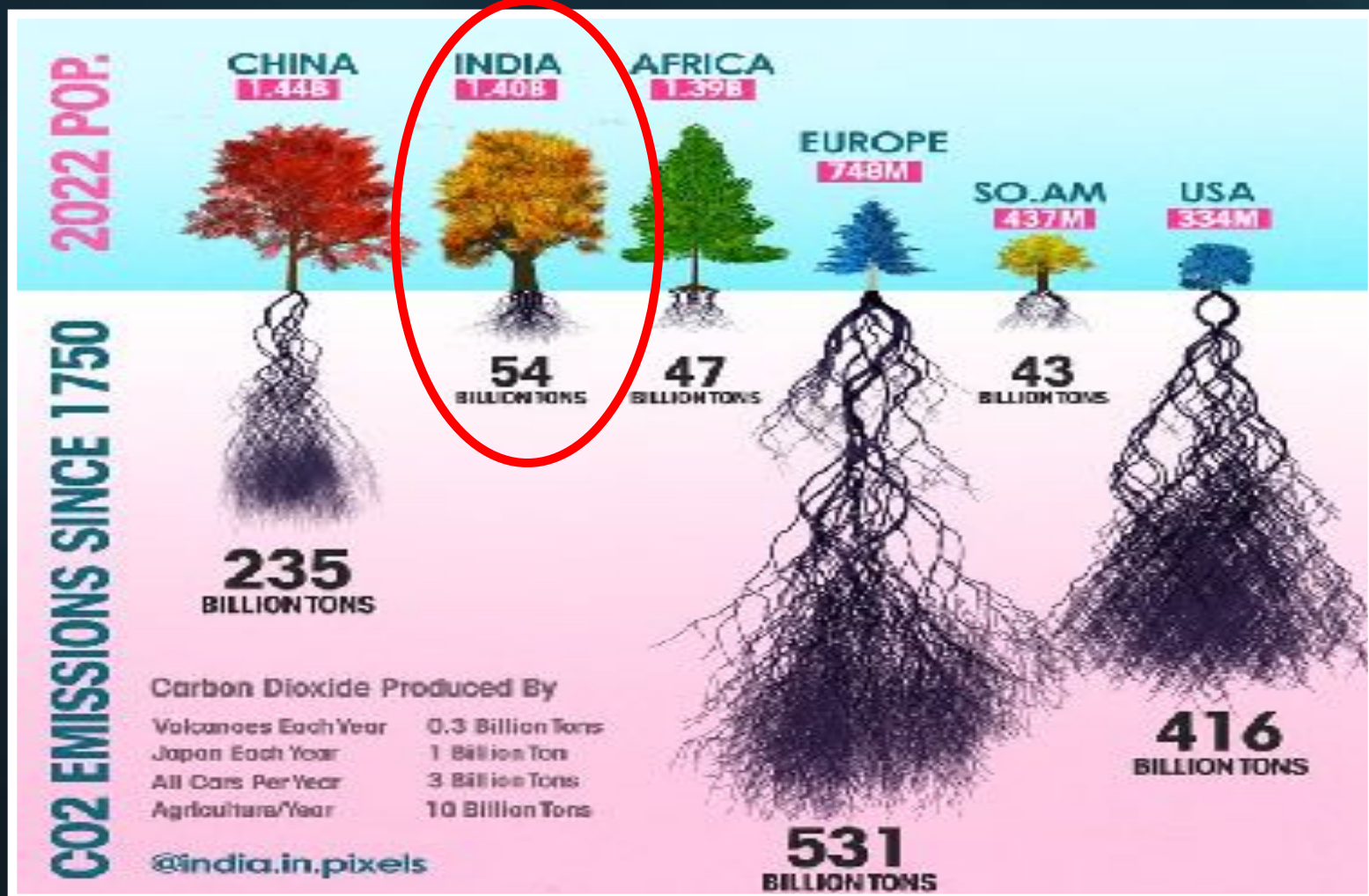
DIESEL CLAIM BY THE STU FROM TN.GOV'T.

S. No.	STU	High Speed Diesel claim for the month of July-2022.
1	MTC	14,94,23,000
2	SETC	10,15,93,000
3	VPM	25,52,67,000
4	SLM	15,91,01,000
5	CBE	21,71,13,000
6	KUM	25,30,64,000
7	MDU	17,77,52,000
8	TNV	13,59,85,000
Total		144,92,98,000

Total Value of Rs 145/- Crores approximately

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CO₂ Production -Global View



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Data's related to Global Emissions

TRAVEL EMISSIONS: WHERE, HOW MUCH

ROAD: Passenger
(Includes cars, motorcycles, buses and taxis)

45.1%

ROAD: Freight
(Includes trucks and lorries)

29.4%

AVIATION
(81% passenger*, 19% freight)

11.6%

SHIPPING
10.6%

OTHER
(Mainly transport of oil, gas, water, steam, and other materials via pipelines)

2.2%

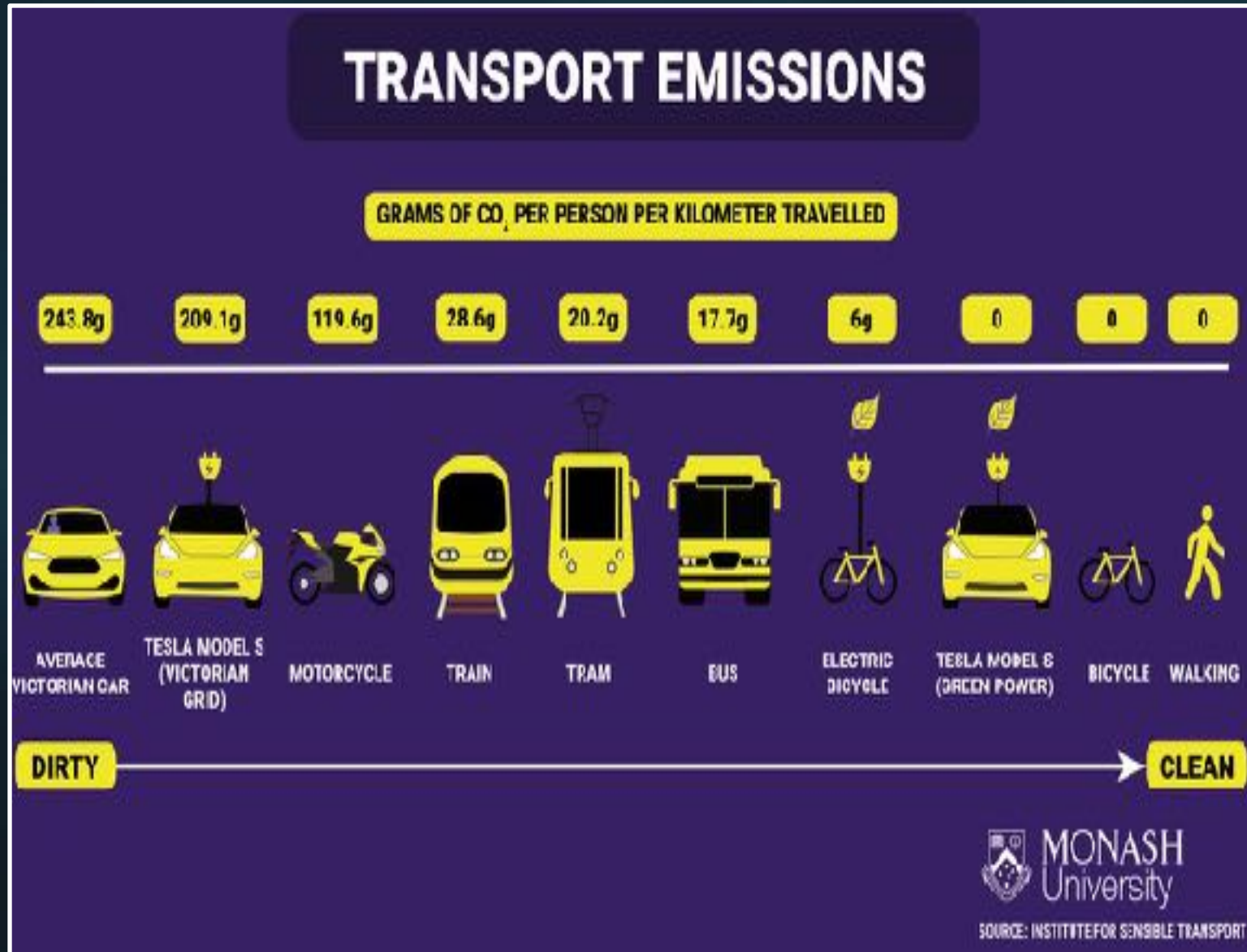
RAIL
1%



*Of passenger emissions, 60% are from international flights, 40% from domestic.

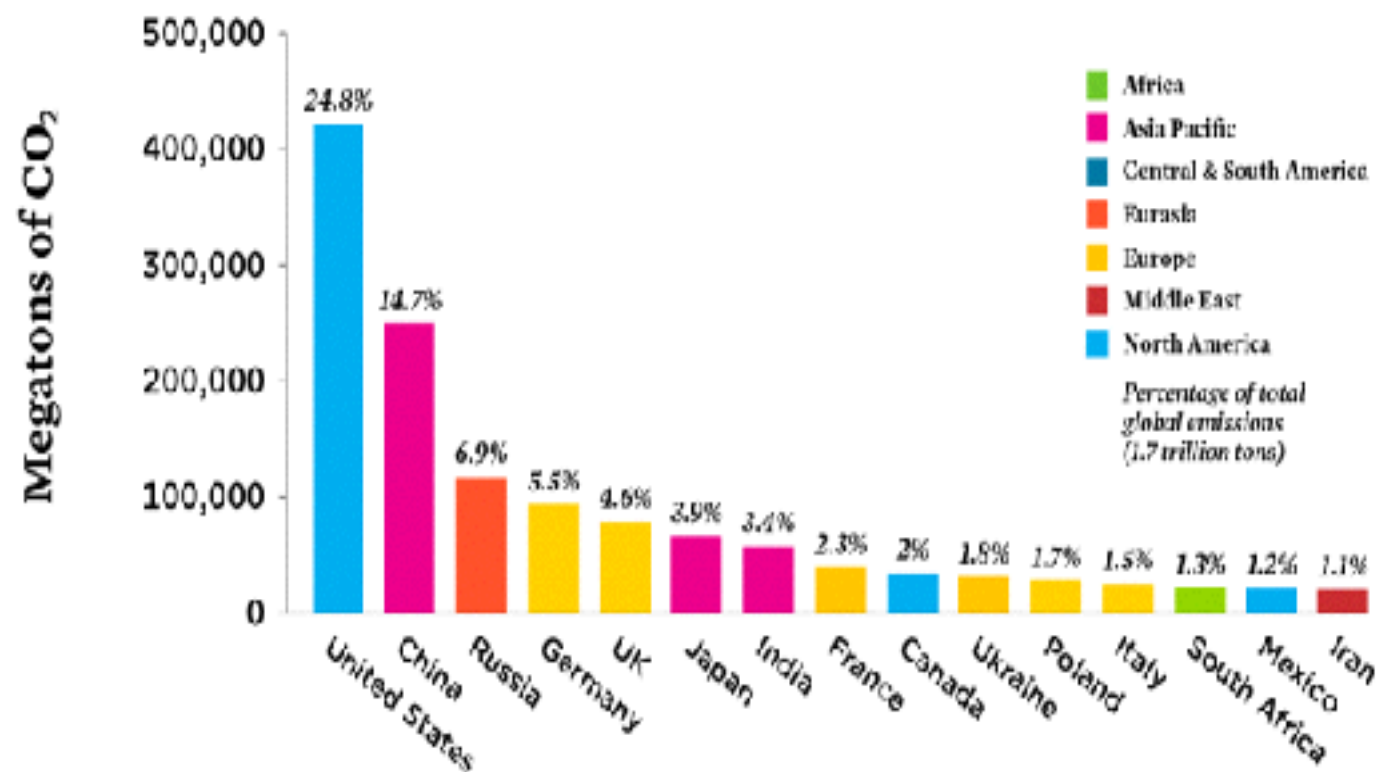
Source: Our World In Data, based on International Energy Agency (IEA) and International Council on Clean Transportation (ICCT)

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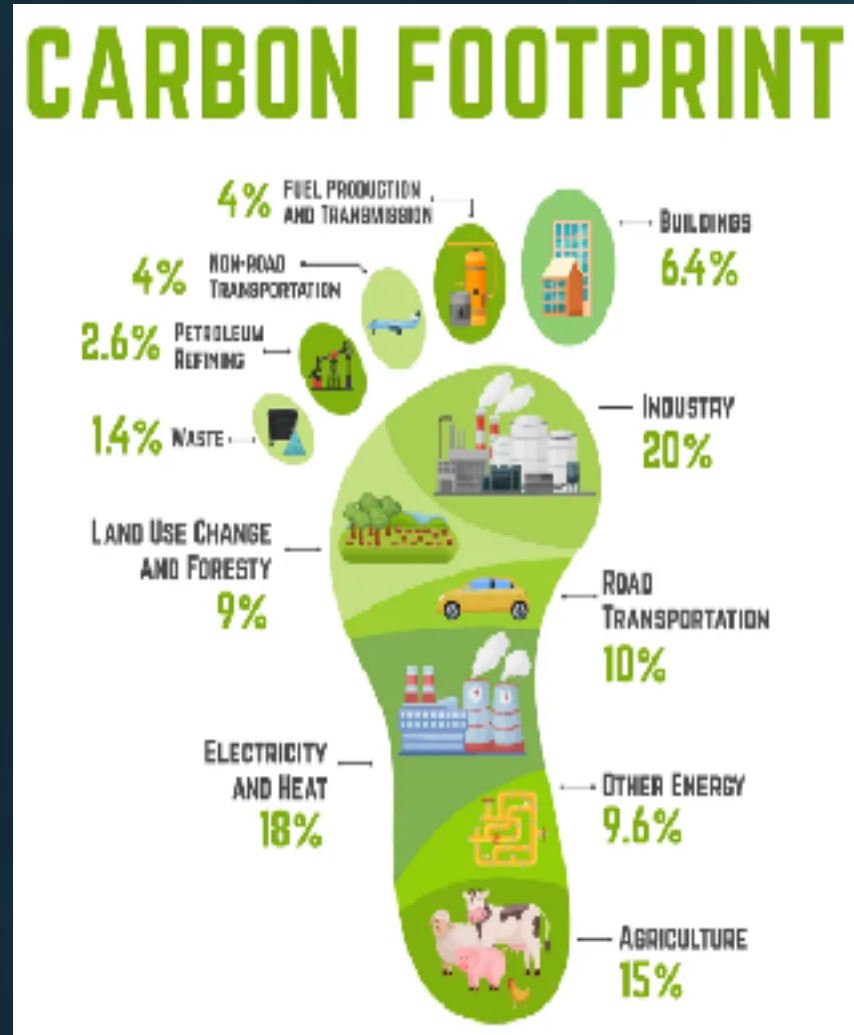
Top CO₂ Emitting Countries, 1750-2021 (from fossil fuels and cement)



© 2023 Union of Concerned Scientists
Data: Global Carbon Project via Our World in Data

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CARBON FOOT PRINT



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ASSOCIATED IMPACTS OF CLIMATE CHANGE

- Frequent severe droughts (கடுமையான வறட்சி)
- Less Rainfall
- Heat Waves
- Heavy Rainfall
- Sea Level Rise
- Corals Bleach (பவளப்பாறைகள் சேதம்)
- Oceans Acidification
- Acid rain fall
- Bio Diversity is being lost
- Tropical Cyclones
- Forest Burning
- Earthquake
- Tsunami



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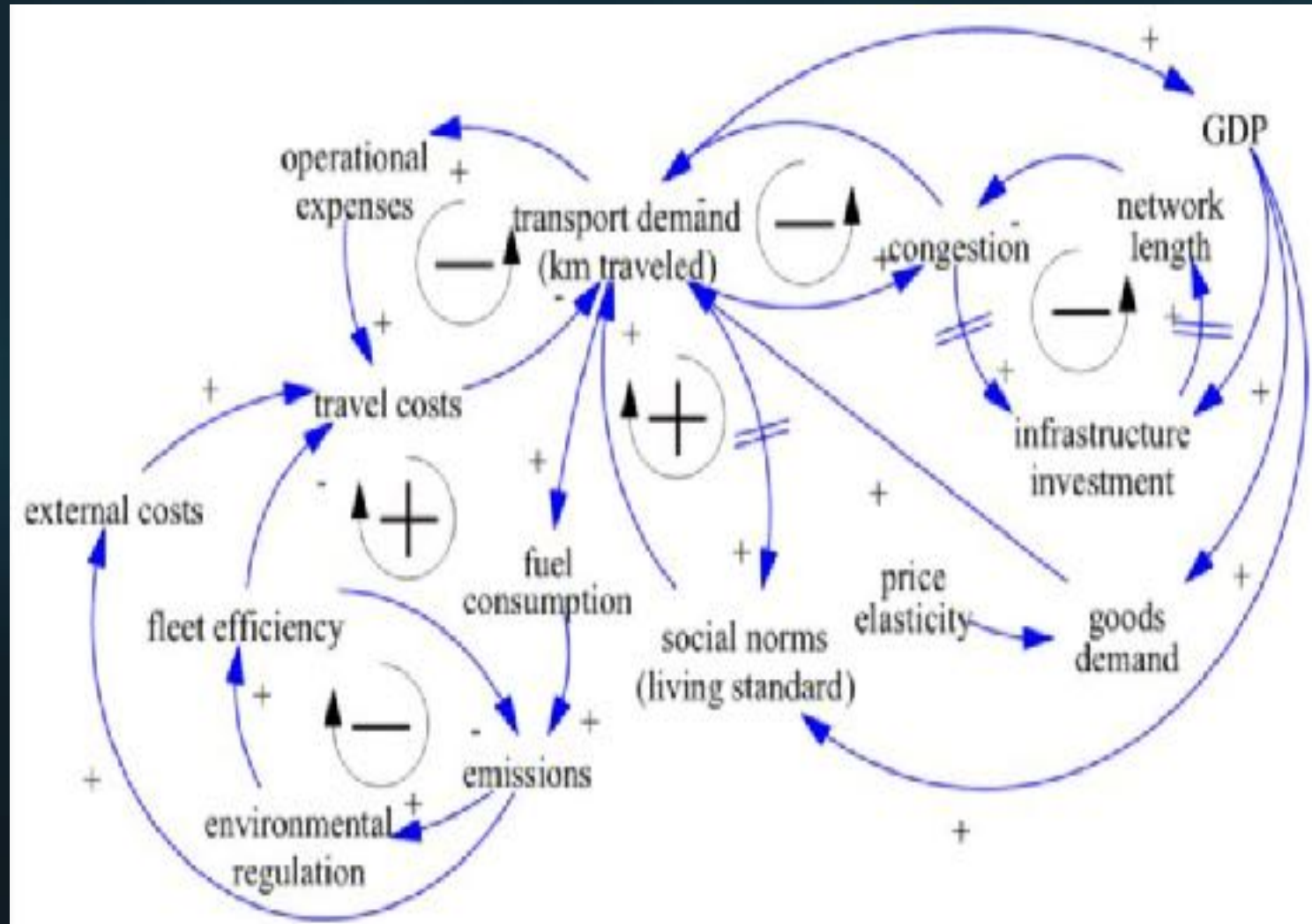
EFFECTS ASSOCIATED WITH CLIMATE CHANGE

- Gender Equity
- Human Rights
- Renewable Energy
- Intersecting Inequalities
- Natural Resources
- Public Services
- Health
- Infrastructures

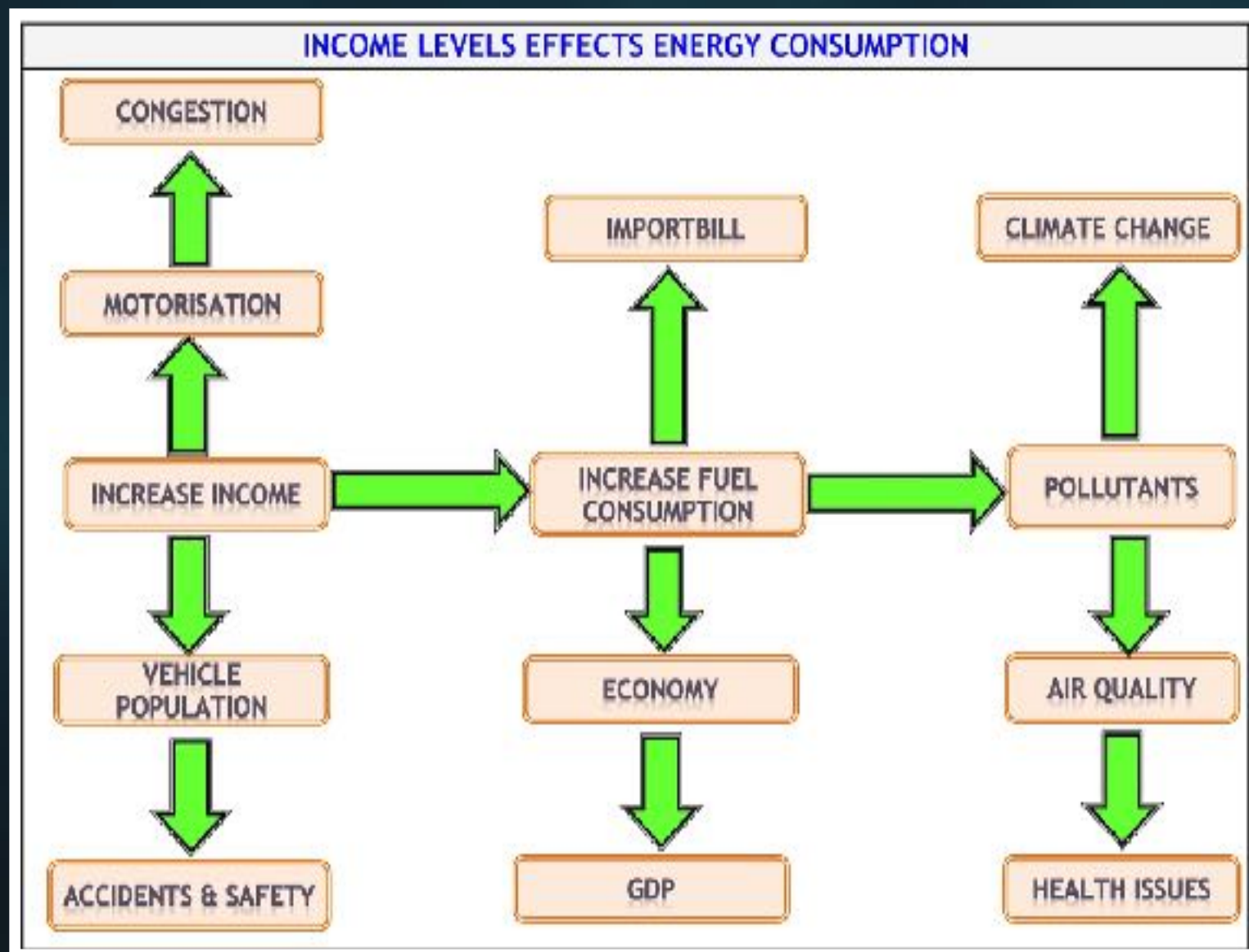


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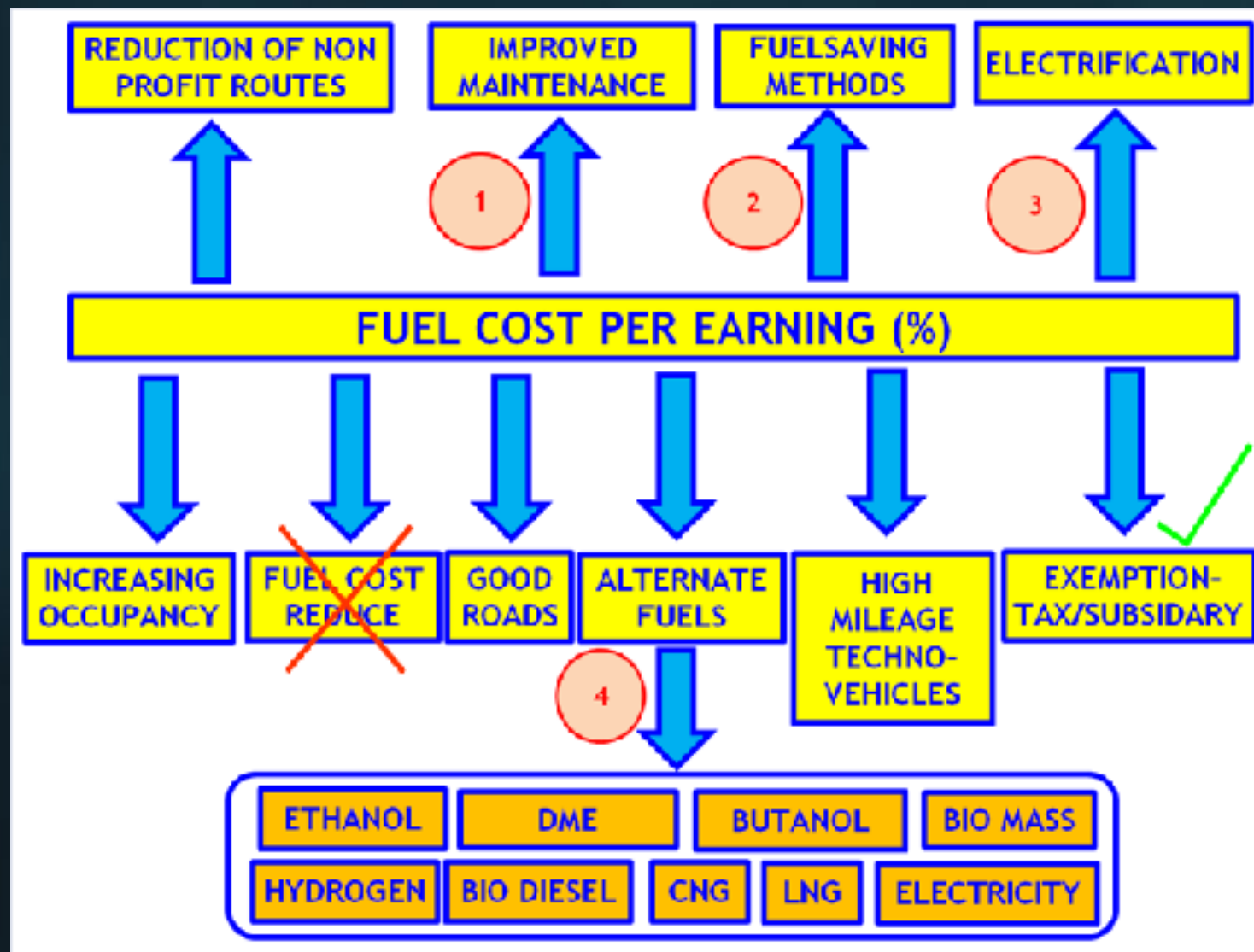
GDP RELATED TRANSPORT & FUEL



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1. IMPROVED MAINTENANCE



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MAINTENANCE PRACTICES IN PUBLIC TRANSIT (Micro)



**PREVENTIVE
MAINTENANCE**



**CORRECTIVE
MAINTENANCE**



**PREDICTIVE
MAINTENANCE**



**CONDITION BASED
MAINTENANCE**



**RELIABILITY CENTERED
MAINTENANCE (RCM)**



**SCHEDULED
MAINTENANCE**



**UNSCHEDULED
MAINTENANCE**



**OVERHAUL &
REFURBISHMENT**



**CLEANING &
HYGIENE**



**SAFETY &
COMPLIANCE**



**INFRASTRUCTURE
MAINTENANCE**



**EMERGENCY
MAINTENANCE**



**ENVIRONMENTAL
MAINTENANCE**



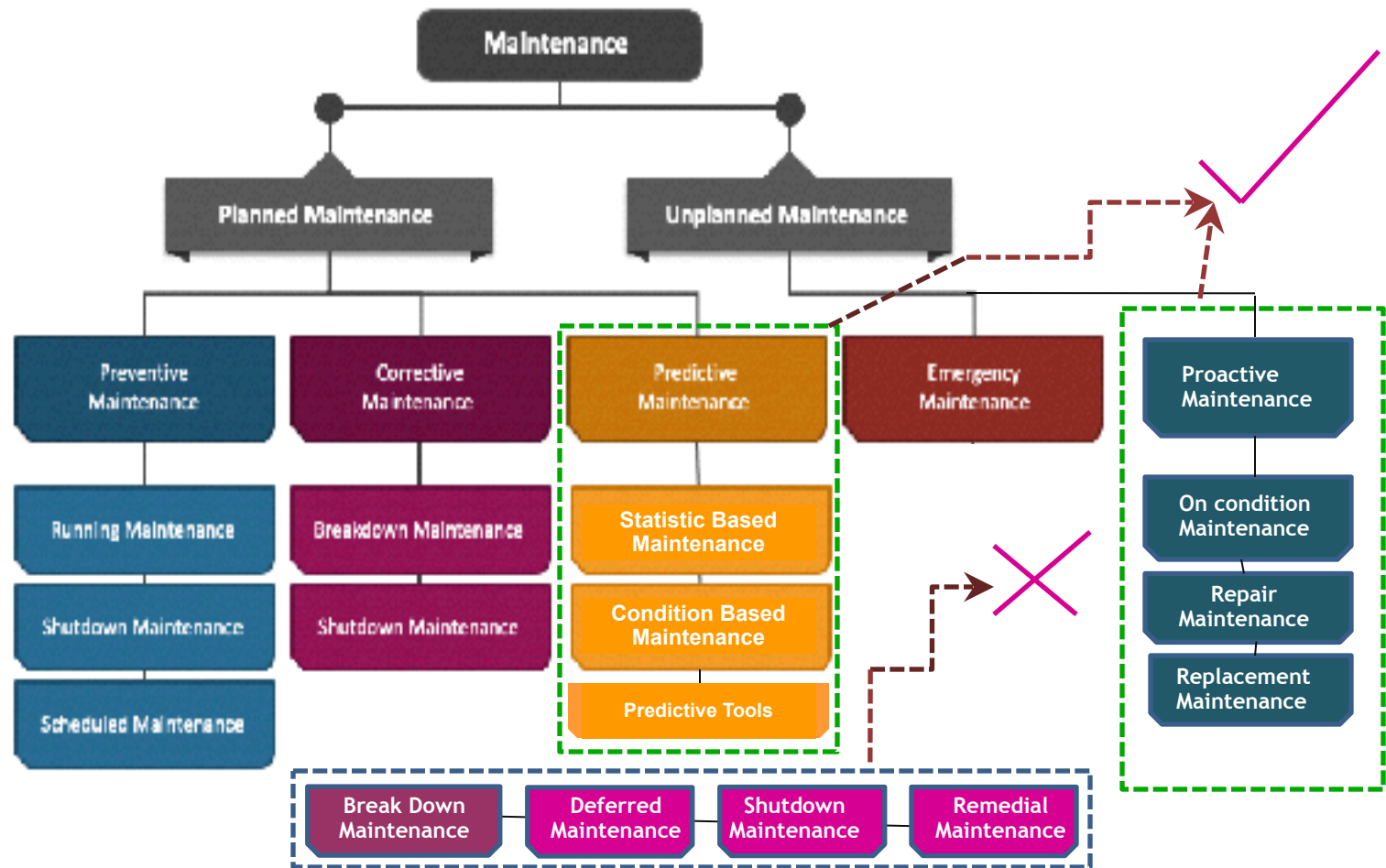
**INFORMATION &
COMMUNICATION
TECHNOLOGY(ICT)
MAINTENANCE**



**FACILITY
MAINTENANCE**

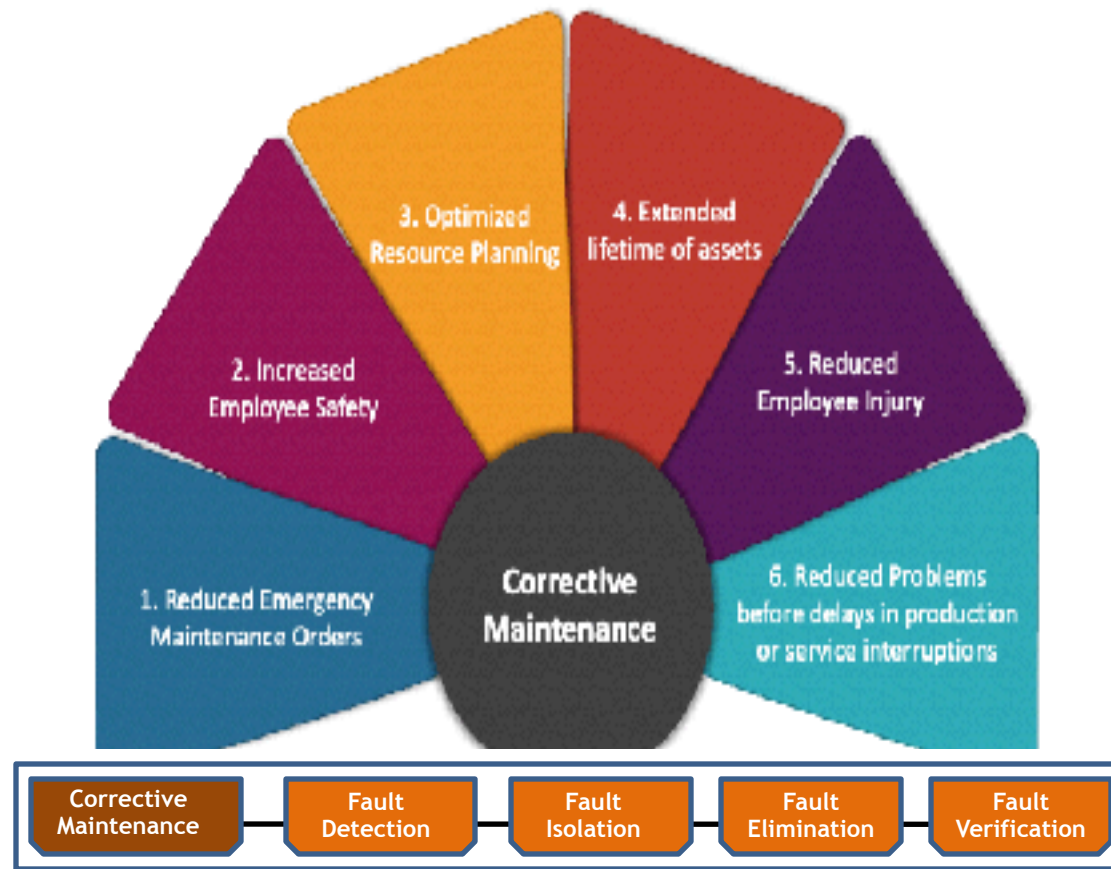
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TYPES OF MAINTENANCE



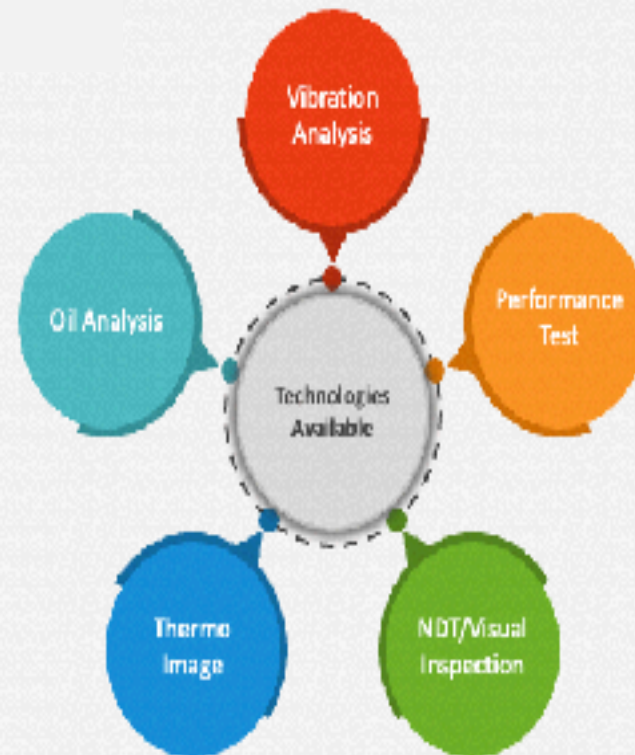
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CORRECTIVE MAINTENANCE



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PREDICTIVE MAINTENANCE TECHNOLOGIES



Predictive maintenance principle uses a combination of measurement on process and machinery to evaluate equipment condition.

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PREDICTIVE MAINTENANCE KEY ELEMENTS



BUS MAINTENANCE



PREDICTIVE MAINTENANCE

- Monitor Wear & Tear
- Avoid Break Downs
- Future Proof



REMOTE DIAGNOSTICS

- Fleet Overview
- Vehicle Overview
- Diagnostics Trouble Codes
- Customized Alerts
- Metrics
- Sensor Readings
- Real Time Notifications



AUTOMATED MAINTENANCE

- Create Plans
- Control Dates Automatically
- Adjust as easily as go

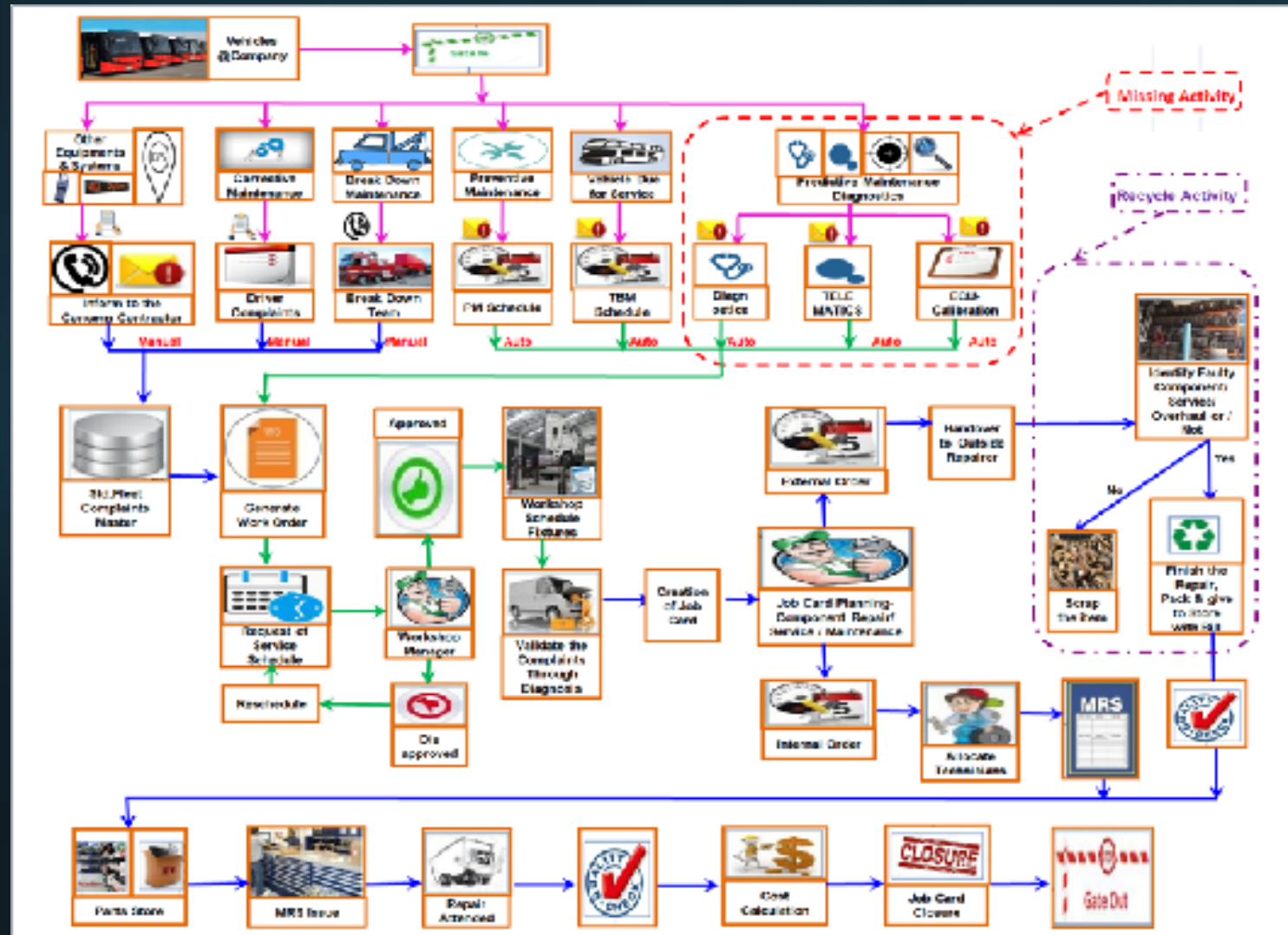
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PREDICTIVE MAINTENANCE BENEFITS



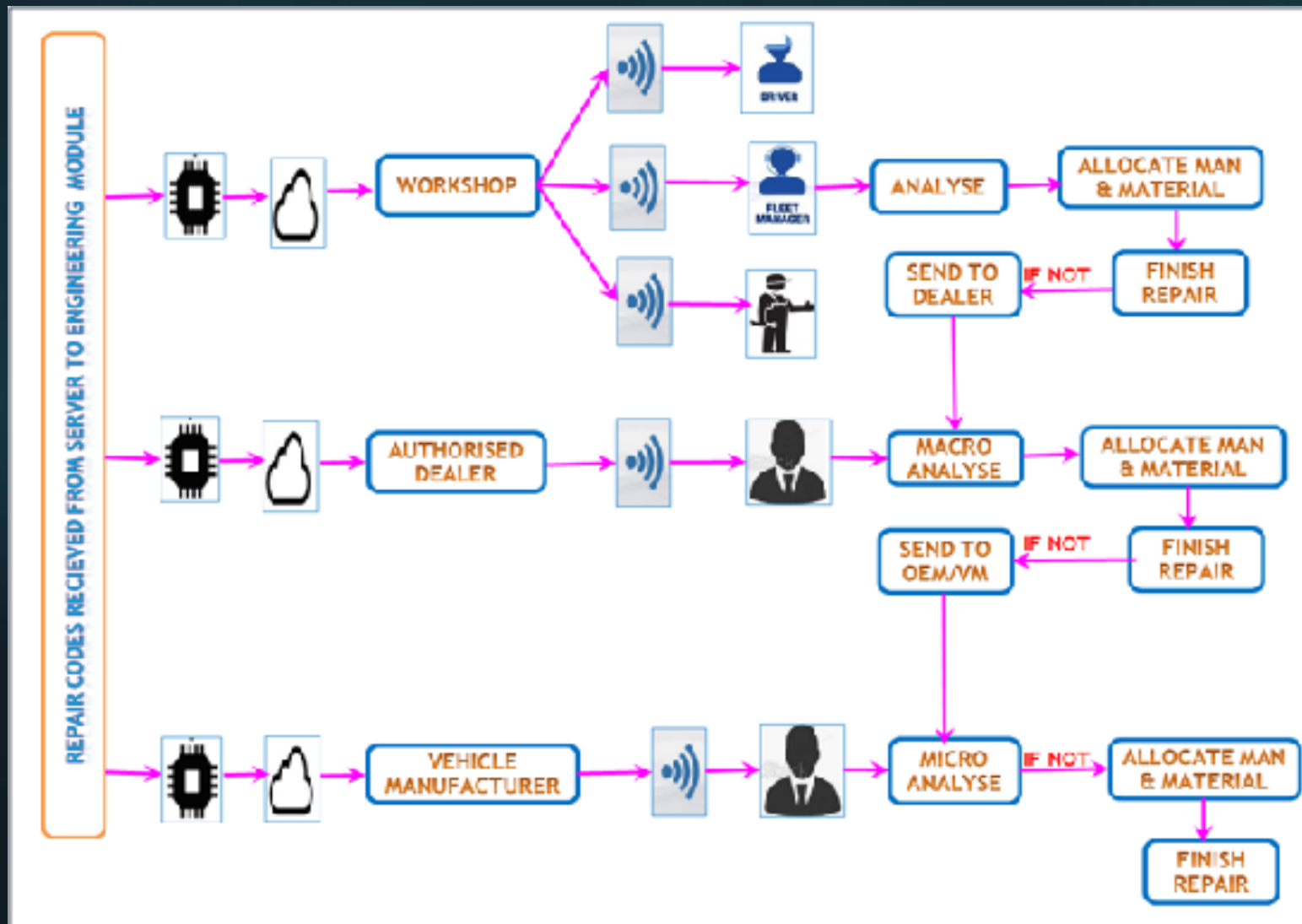
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MAINTENANCE FLOW CHART



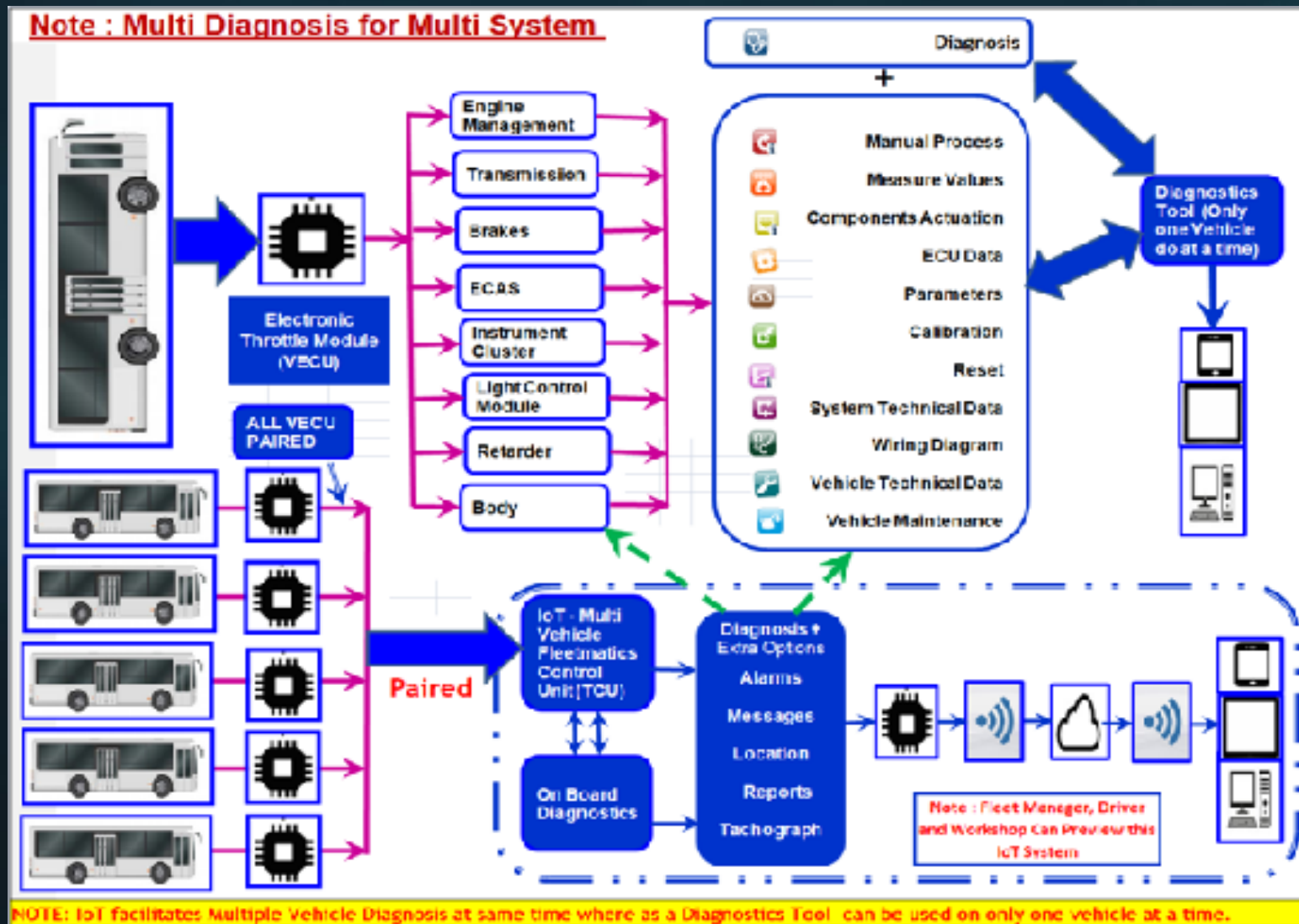
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OEM/STU's VEHICLE MAINTENANCE FLOW CHART



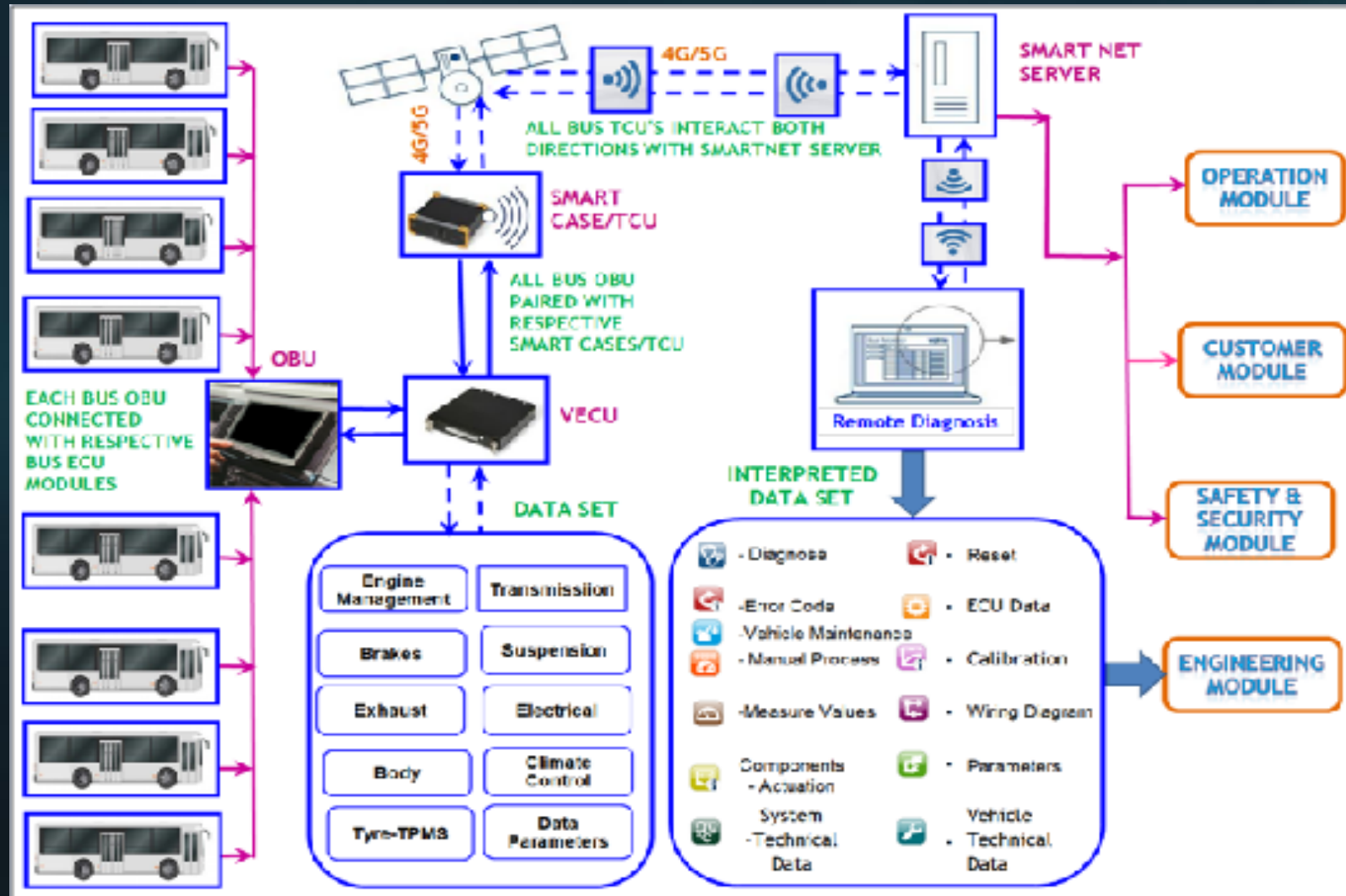
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DIFFERENCE BETWEEN DIAGNOSTIC TOOL & IoT



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SMART MONITORING OF BUSES



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DIAGNOSTICS RESULTS - DATA SHEET

Vehicle Make :MAN NEOPLAN VEHICLE MODEL :CITY LINER														
Sl	System	Models	Legend to Measure											
			Manual Process	Diagnosis	Measure Values	Components Activation	ECU Data	Parameters	Calibration	Reset	System Technical Data	Wiring Diagram	Vehicle Technical Data	Vehicle Maintenance
1	Antipollution	HC&COx Reduct, Exhaust gas treatment system												
2	Antipollution	Nox/Ox, Exhaust gas treatment system												
3	Heater	Thermo S 350, Auxiliary heater												
4	Gearbox	AG Tronic, Gearbox with electronic control												
5	Gearbox	AG Tronic, Gearbox with electronic control												
6	Climate/HVAC	CU HR 48x, Climate control												
7	Control computer	PPR, Vehicle control unit												
8	Control computer	CCDU, On-board diagnostic unit												
9	Control computer	CMU 3, Body computer												
10	Wheel pressure control	TPM, Tyre pressure control												
11	Brakes	CEU, Brake control unit												
12	Instrument cluster	IMS 6T06, Instrument cluster												
13	Maintenance	Service H-H, Maintenance												
14	Electronic module	NTS CAN, Modular Door Control System												
15	Electronic module	NTS K-Line, Modular Door Control System												
16	Engine	EDC 17, Electronic Diesel Control, Common Rail												
17	Engine	EDC 7, Electronic Diesel Control, Common Rail												
18	Multiplex	ZDR0 32, Multiplexer												
19	Radio/navigation, telematics and FMS	Radio Navigation System, Navigator												
20	Radio/navigation, telematics and FMS	ISM, Telematic module												
21	Retarder	EXHA, Retarder												
22	Safety	ACC, Adaptive Cruise Control												
23	Safety	LGS, Lane Departure Warning Assistant												
24	SEASIDEION	RUCR-CAC 3, Emergency Controlled Air Suspension												
		EXHENDIS												

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FUEL SAVING SYSTEMS & TECHNIQUES



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2.FUEL SAVING TECHNIQUES



Smooth driving



Steady Speed



Proper Tyre Maintenance



Synthetic Oils Usage



Lighten the Load (Goods)



Aero Dynamics



Proper Maintenance



Use Right Fuel



Plan the Apt Trip



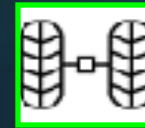
Avoid Excess Idling



Use Apt Gears



Apt level - A/c Use



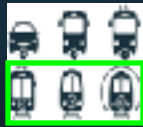
Axle Alignment



Check Battery Cables



Accelerate when need



Alternative Modes



Monitor Fuel Economy



Avoid Rapid Start



Smart Driving



No Fast Driving



Hi-Mileage Techno Vehicles



Use Cruise Control



Time of Fuel Pump



Clean Air filter



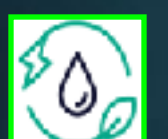
Avoid Rush Hour Travel



Use Fast Tag



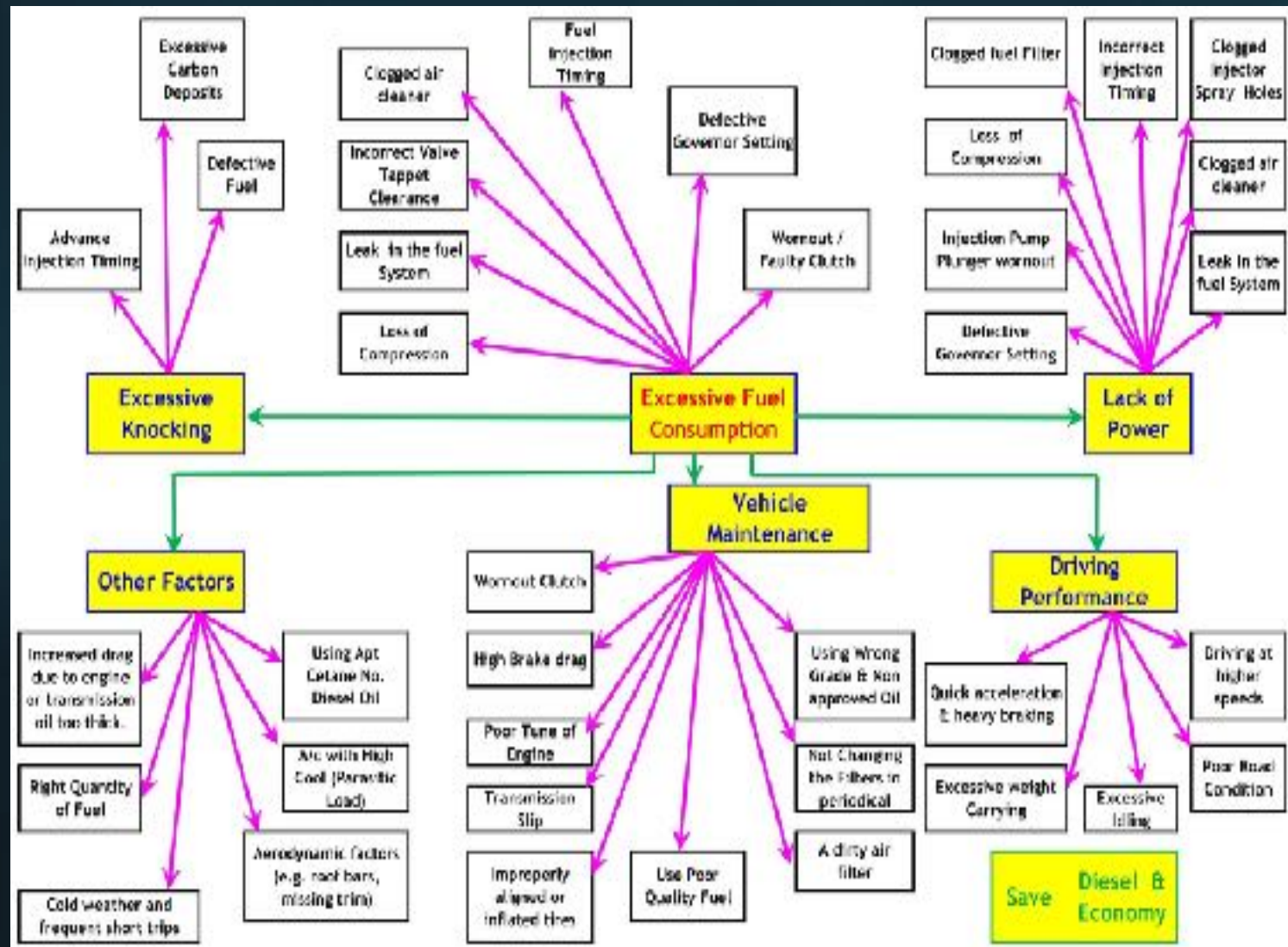
Avoid Overfilling



Use Alternate Fuels & Drives

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FUEL SAVING - CONSUMPTION REDUCTION



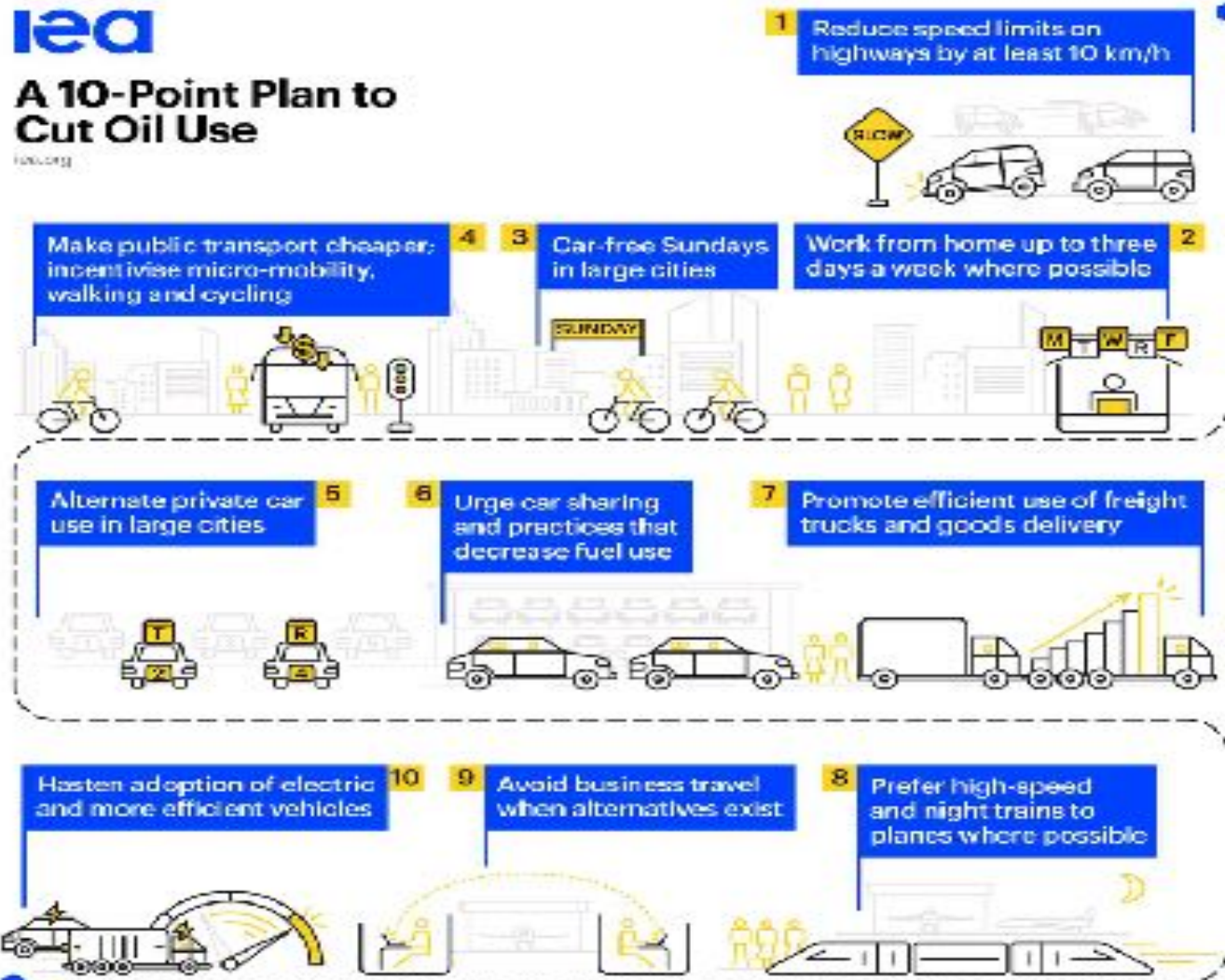
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PLAN TO CUT OIL USE - 10 POINTS



A 10-Point Plan to Cut Oil Use

iea.org



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3.ELECTRIFICATION

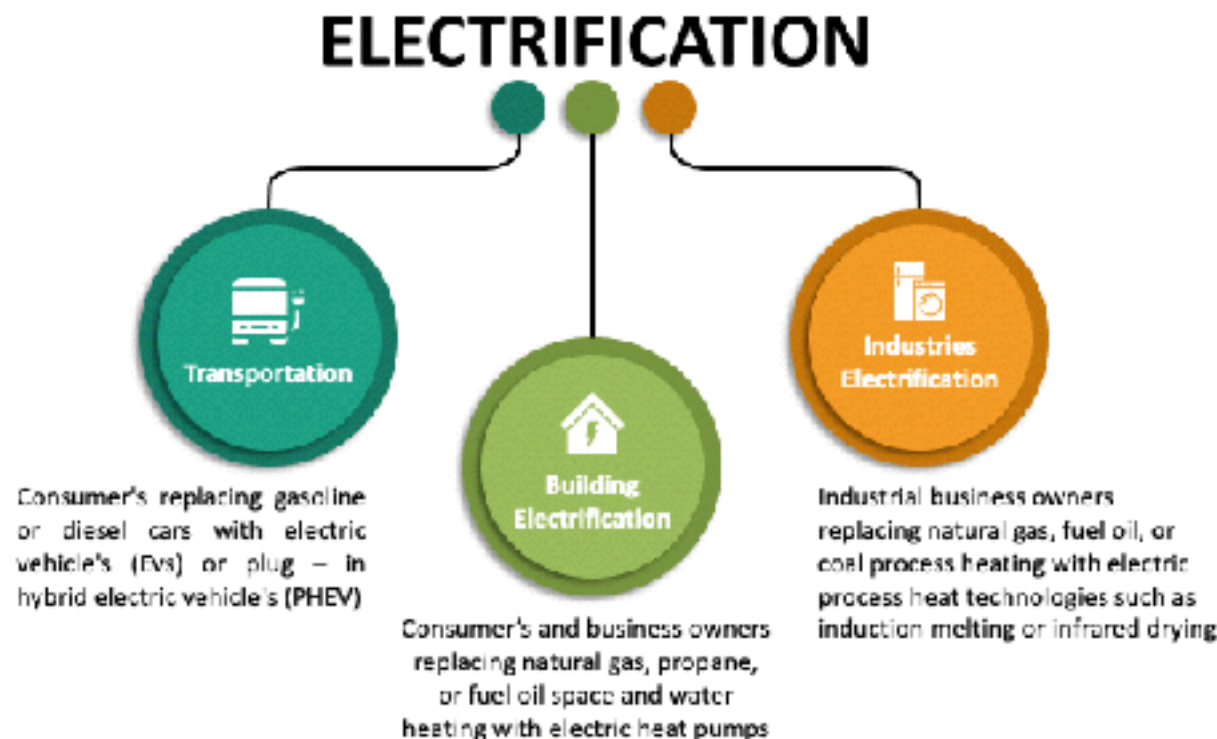


ELECTRIFICATION

Electrification refers to the process of utilising electric power to operate vehicles/machinery/buildings. It involves the conversion of other forms of energy , such as chemical or mechanical, into electrical energy to power electrical devices. Electrification has led to significant advances in technology and has played a vital role in modernising various industries.

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ELECTRIFICATION



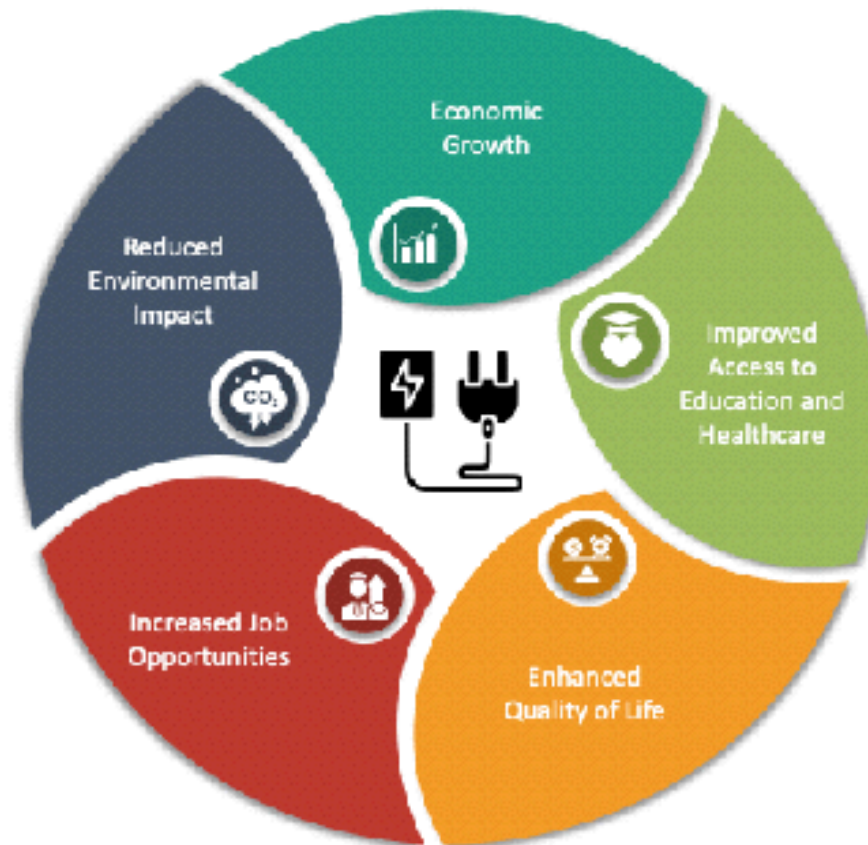
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WHY ELECTRIFICATION IMPORTANT ?



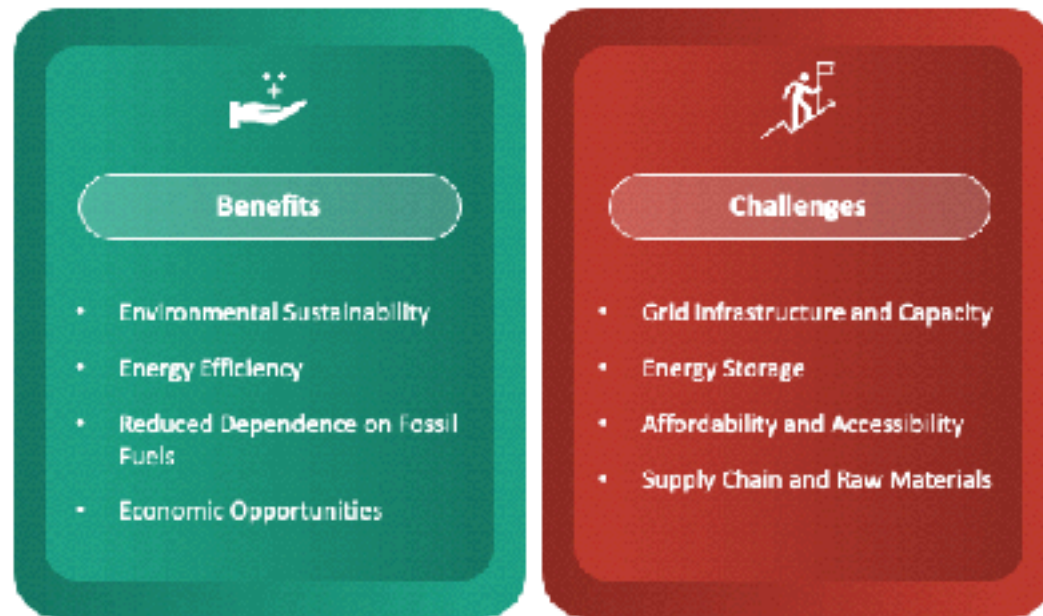
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ELECTRIFICATION IMPACTS



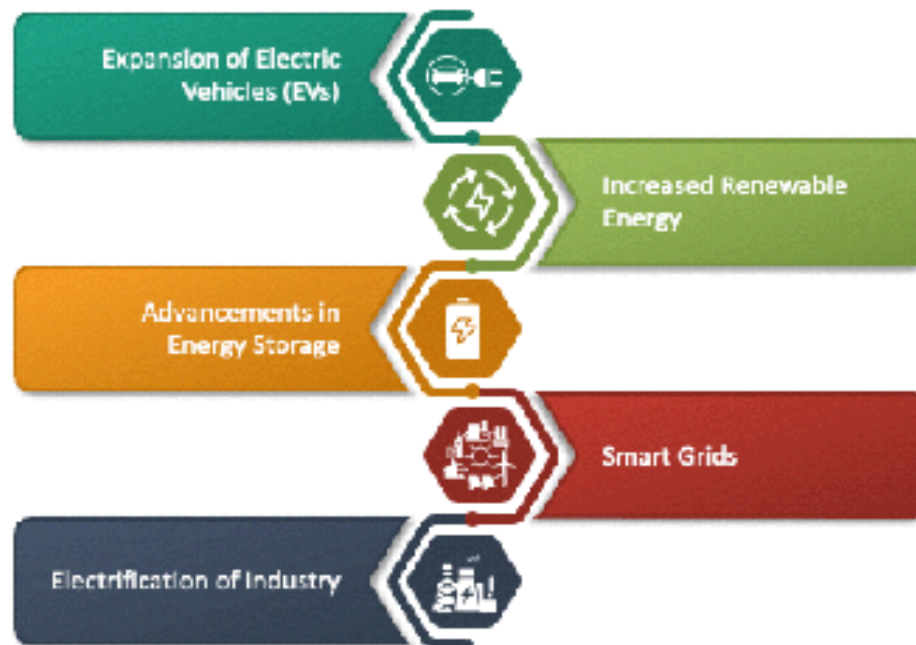
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ELECTRIFICATION BENEFITS & CHALLENGES



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FUTURE OF ELECTRIFICATION



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ELECTRIC VEHICLE TYPES

EV (Electric Vehicle)		• No IC engine • Only electric drive • Battery pack size is large (20-80 kwh) • Example: Nissan Leaf, Tesla Model S
HEV (Hybrid Electric Vehicle)		• Has IC engine and electric motor • The batteries get charged by the engine • Battery pack size is medium (6-12 kwh) • Example : Honda Civic Hybrid
PHEV (Plug-in-Hybrid Vehicle)		• Has IC engine and electric motor • The batteries can be charged from an external source (plug) • Example: BMW i-8
MHEV (Mild Hybrid Vehicle)		• IC engine and electric motor • Turns off the engine and switches to motor when coasting, braking and restarting quickly • Cannot be solely driven on electric motor • Example: Chevrolet Silverado Hybrid

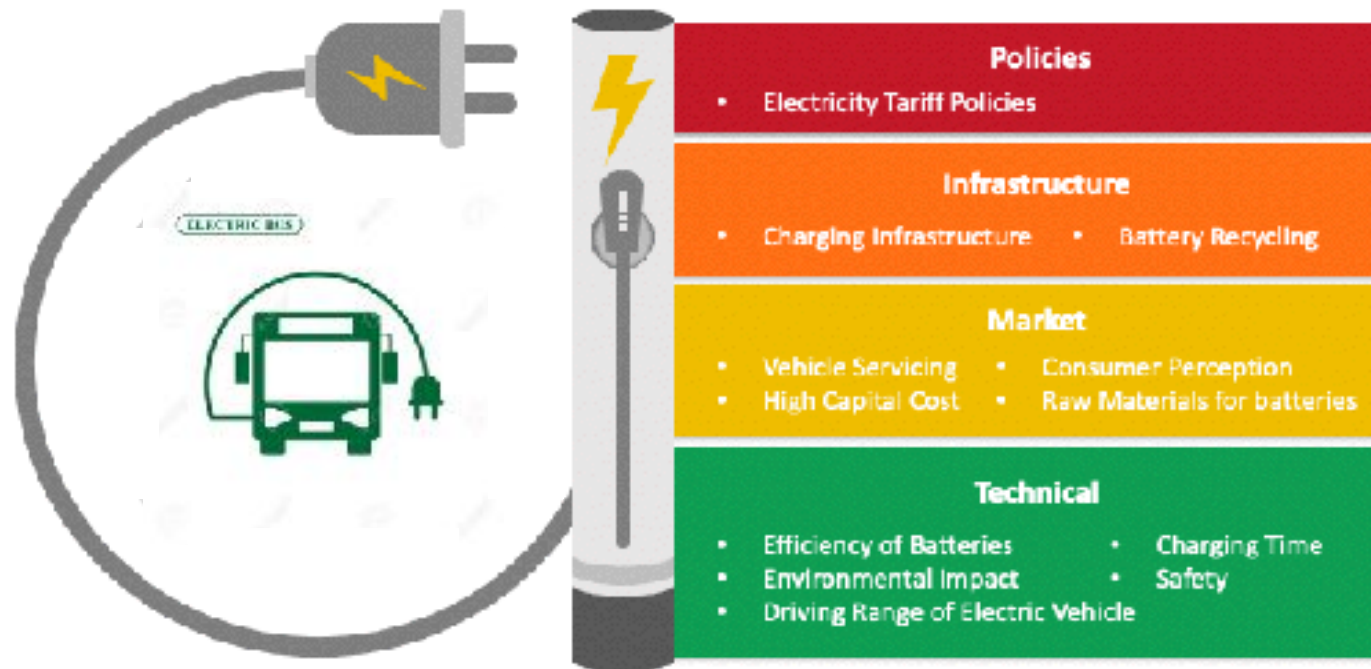
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ELECTRIFICATION : ELECTRIC BUS CHALLENGES



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ELECTRIC BUS BARRIERS



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WHY WE NEED ELECTRIC BUS ?



IMPROVE
LOCAL
AIR QUALITY



REDUCE
NOISE FROM
TRANSPORT



IMPROVE PT
ACCESSIBILITY
IN URBAN
AREAS



CO₂ AND GHG
SDG
REDUCTION
TARGETS



BUILD ENERGY
SOURCE DIVERSITY
& RENEWABLE
STORAGE CAPACITY



IMPROVE
IMAGE OF
LOCAL BUSES



IMPROVE
PUBLIC TRANSIT
MARKET SHARE



REDUCE
OPERATING
COSTS

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ELECTRIC BUS PRO'S & CONS



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ELECTRIC BUS

01

Electric buses are powered by an electric motor that uses electricity in a battery pack

02

When the driver presses the accelerator pedal, the electric motor converts the electrical energy from the battery into mechanical energy, which propels the bus forward.

03

The Battery pack is charged by plugging the bus into an external power source such as a charging station or a house hold electrical outlet.

04

The Charging process can take several hours or more, depending on the type of charger and the capacity of the battery.

05

Electric Buses use regenerative braking, which captures some of the energy that would otherwise be lost during braking and converts it into electrical energy to recharge the battery.

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ELECTRIFICATION : ELECTRIC BUS



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ARTICULATED BUS ELECTRICITY CHARGING



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ARTICULATED BUS ELECTRICITY CHARGING



Between 1.65 and 1.84 kilowatt hours per Km for articulated bus
(a 18-meter bus with 350 kWh of capacity can cover a range between 190 & 210 Km)
12metre buses with full-electric heating, “diluted” over 100 km, stands in the range
between 179 and 235 kWh.

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ARTICULATED BUS ELECTRICITY CHARGING



**Between 1.65 and 1.84 kilowatt hours per Km for articulated bus
(a 18-meter bus with 350 kWh of capacity can cover a range between 190 & 210 Km)**

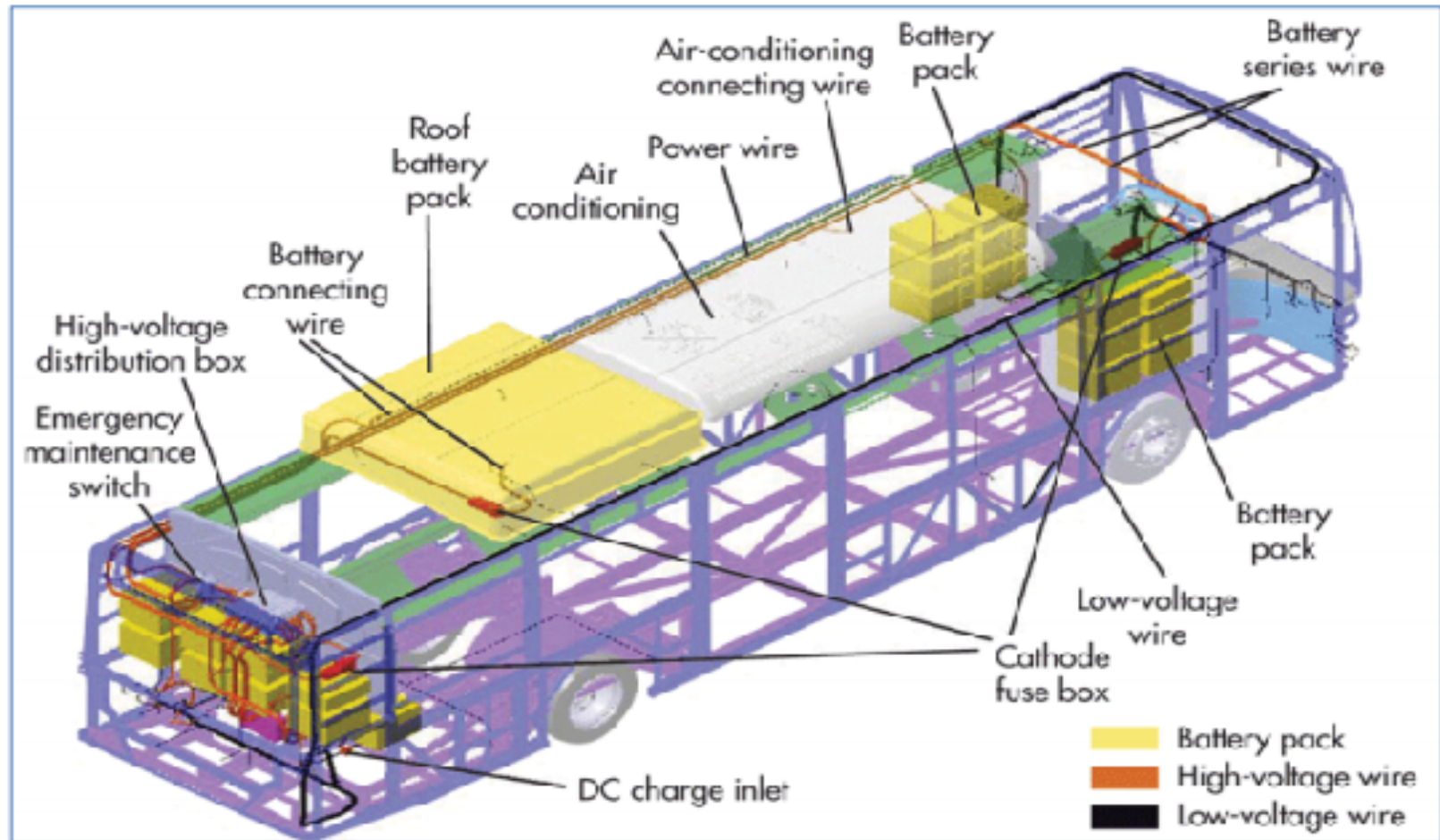
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DOUBLE DECKER E- BUS



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ELECTRIC BUS : ELECTRICAL LAYOUT - BATTERY



(Austin 2013)

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BATTERY MODEL CHARGING E-BUS



BATTERY SWAPPING



UP PANTOGRAPH



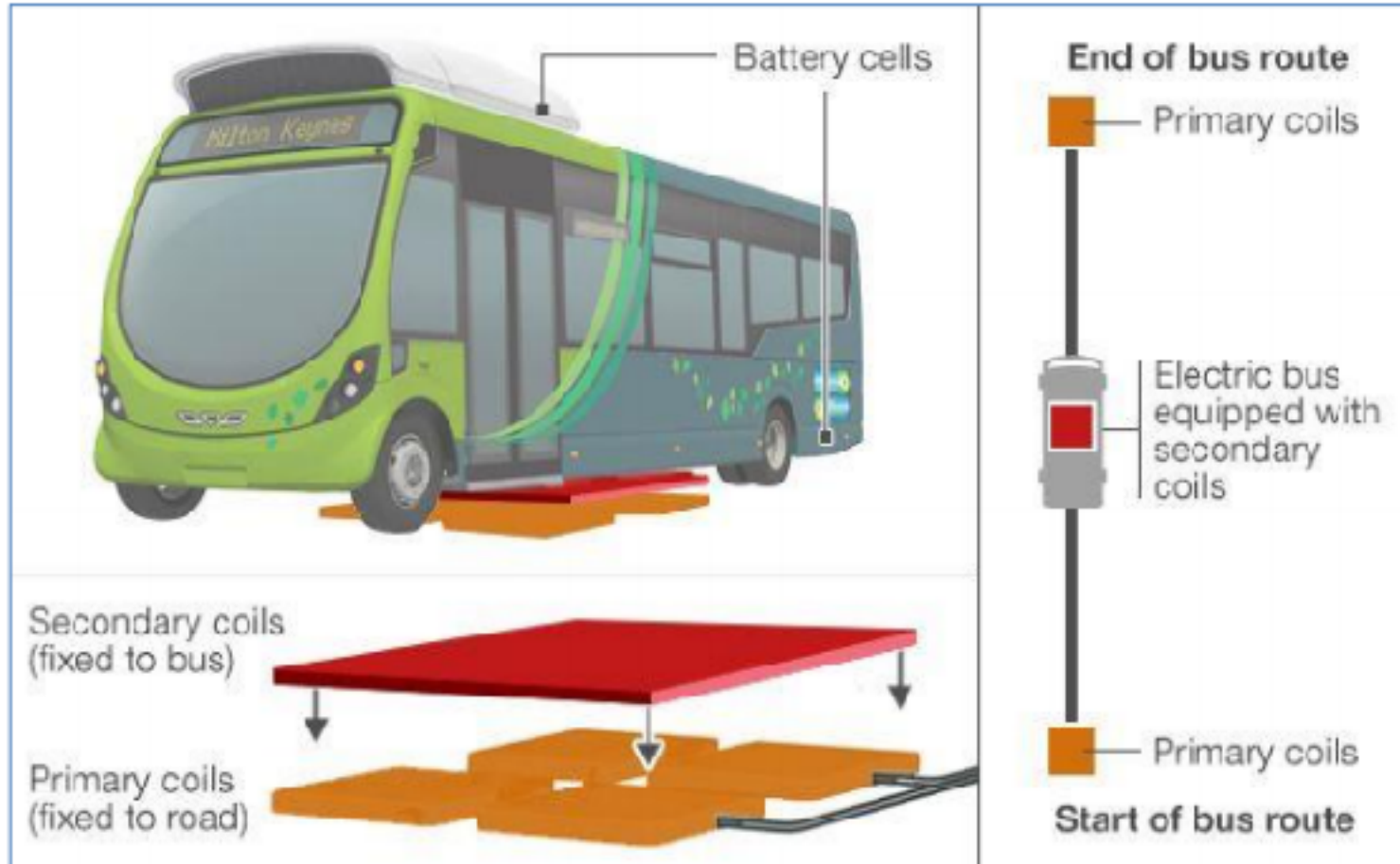
DOWN PANTOGRAPH



FLASH CHARGING

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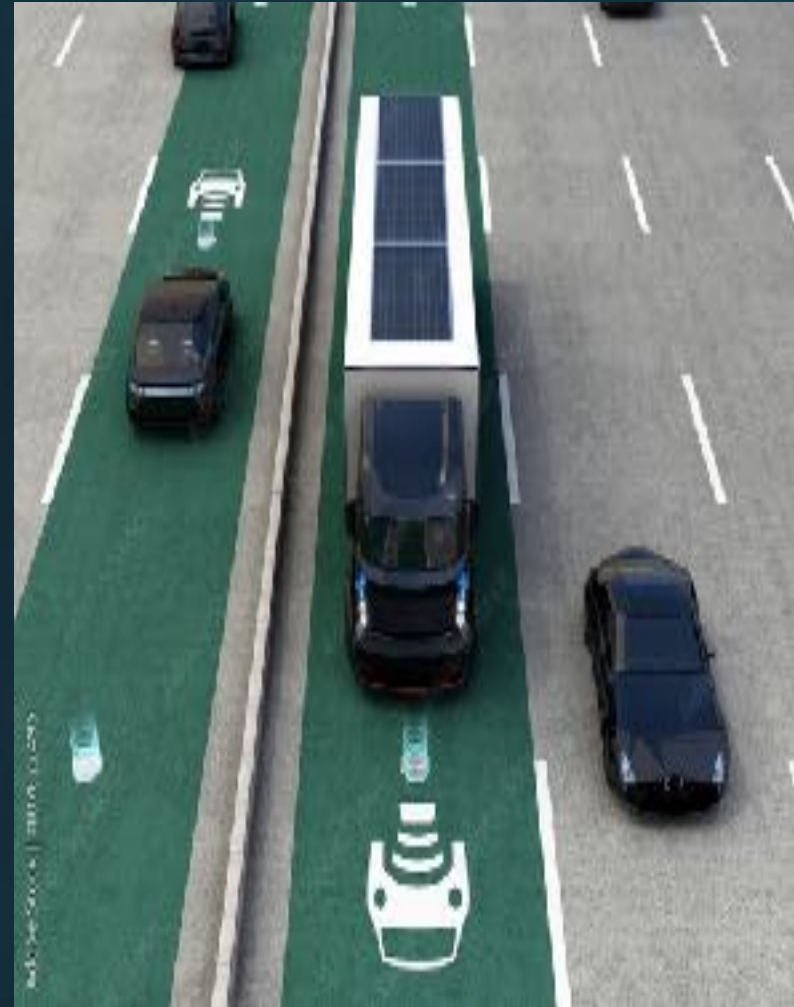
INDUCTING MODEL CHARGING E-BUS



(Science, Reporter, and News 2015)

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INDUCTING MODEL CHARGING E-BUS



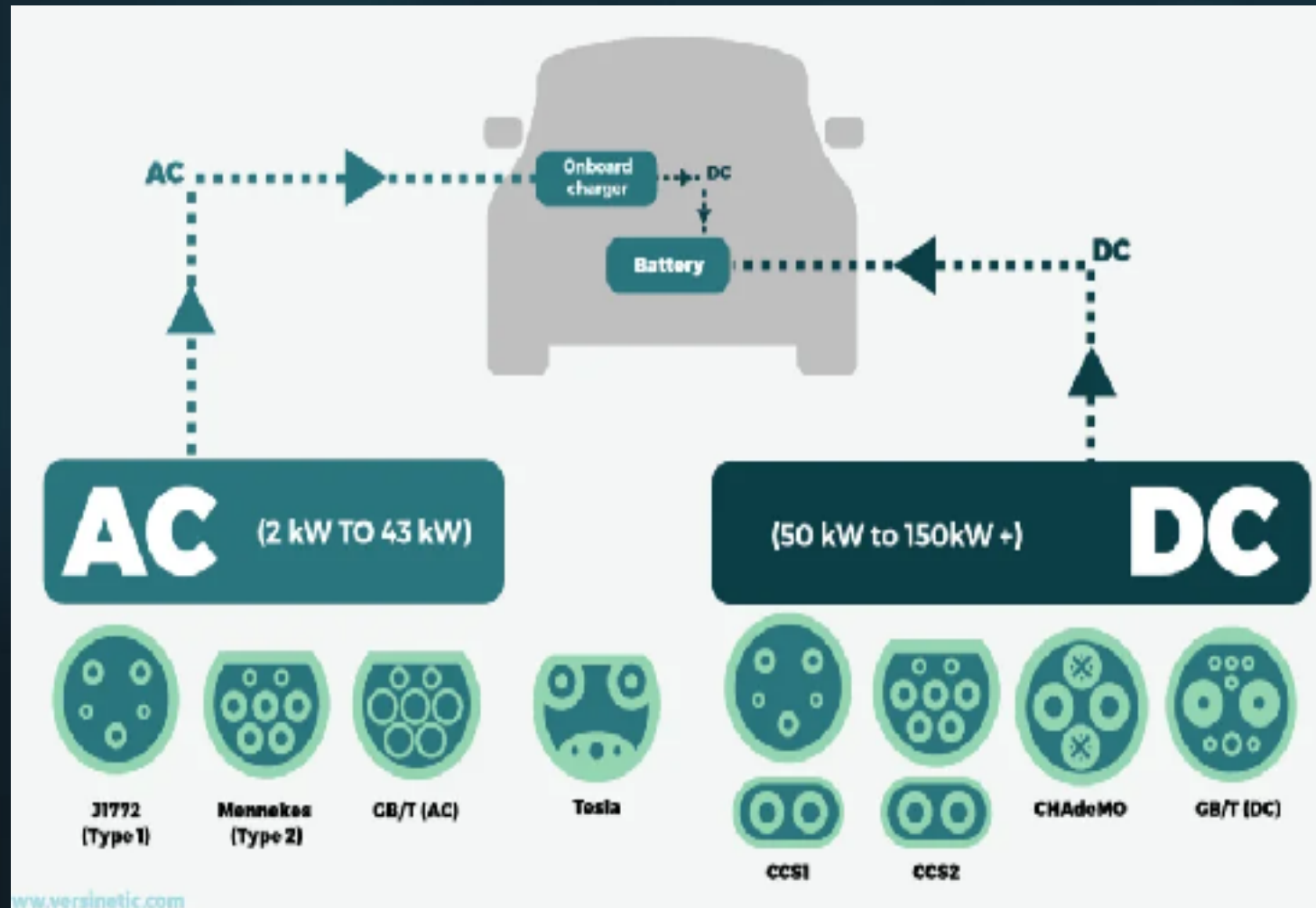
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INDUCTING MODEL CHARGING E-BUS



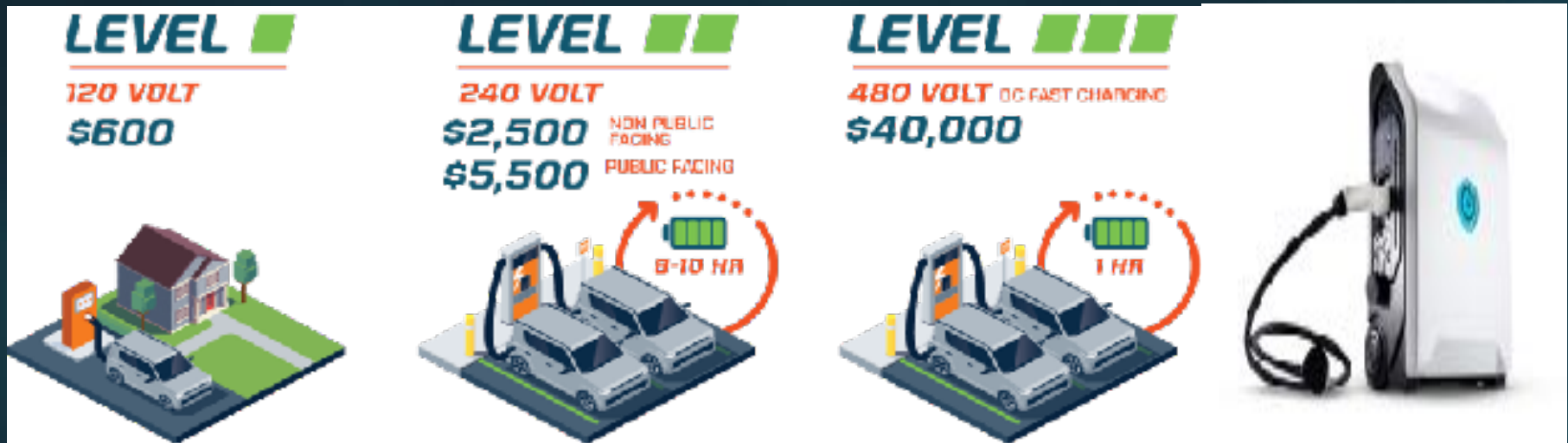
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EV CHARGING CONNECTORS



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BATTERY CHARGING METHODS



1. Level 1 Charging
(120V AC)

2. Level 2 Charging
(240V AC)

3. DC FAST CHARGING

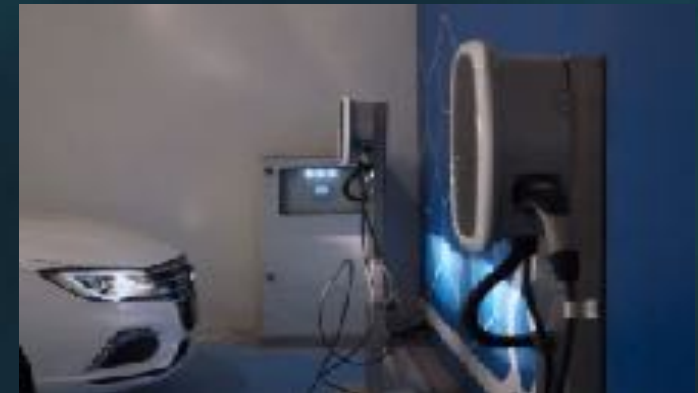
4. PORTABLE CHARGERS



5. TESLA SUPER CHARGERS



6. WIRELESS CHARGING



7. RESIDENTIAL COMMERCIAL CHARGERS

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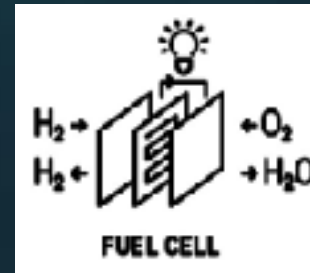
BATTERY TYPES



Lead-Acid



Lithium-ion



Fuel Cell



Nickel-Metal Hydride



Sodium-Ion



Solid-State



GEL LEAD ACID



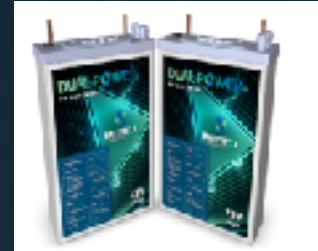
AGM



Super Capacitors



Ultra Capacitors



Smart Battery



Redox Battery

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BATTERY TYPES (Lithium, Nickel based etc)

NICKEL BASED BATTERIES



NICKEL BASED BATTERIES

Nickel-cadmium (NiCd)
Nickel-metal-hydride (NiMH)
Nickel-iron (NiFe)
Nickel-zinc (NiZn)
Nickel-hydrogen (NiH)

FUTURE BATTERIES

Lithium-air (Li-air)
Lithium-metal (Li-metal)
Solid-state Lithium
Lithium-Sulfur (Li-S)
Sodium-ion (Na-ion)
Sodium-Nickel Chloride (Na-NiCl₂)

LITHIUM ION BATTERIES



LITHIUM ION BASED BATTERIES

Lithium Cobalt Oxide (LiCoO₂) – LCO
Lithium Manganese Oxide (LiMn₂O₄) – LMO
Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO₂) – NMC
Lithium Iron Phosphate (LiFePO₄) – LFP
Lithium Nickel Cobalt Aluminum Oxide (LiNiCoAlO₂) – NCA

SMART BATTERY

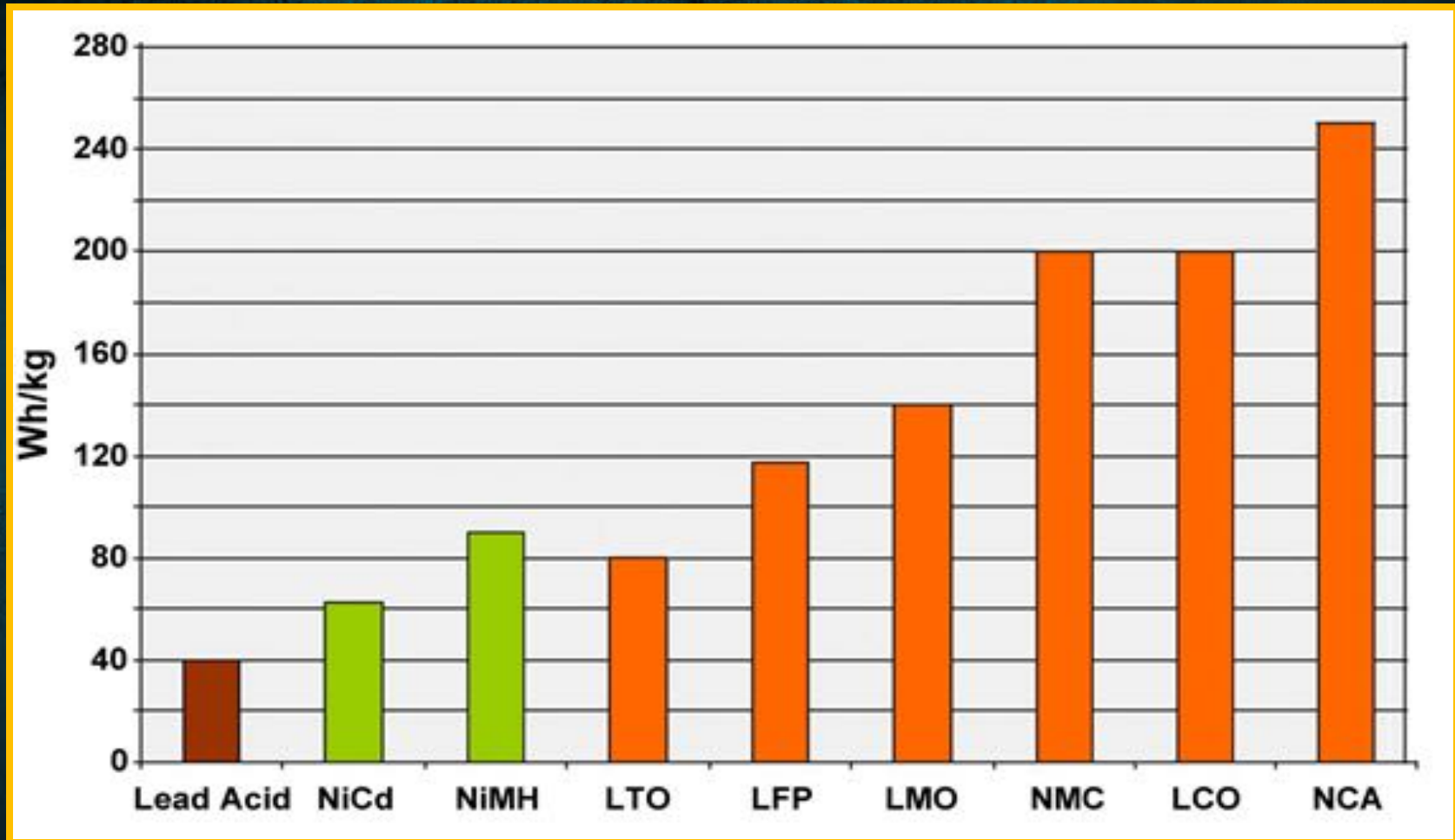
SINGLE WIRE BUS
SM BUS

REDOX BATTERY

Hydrogen bromine
Iron-chrome
Vanadium/Polyhalide
Vanadium/Vanadium
Bromine polysulphide
Zinc-Bromine

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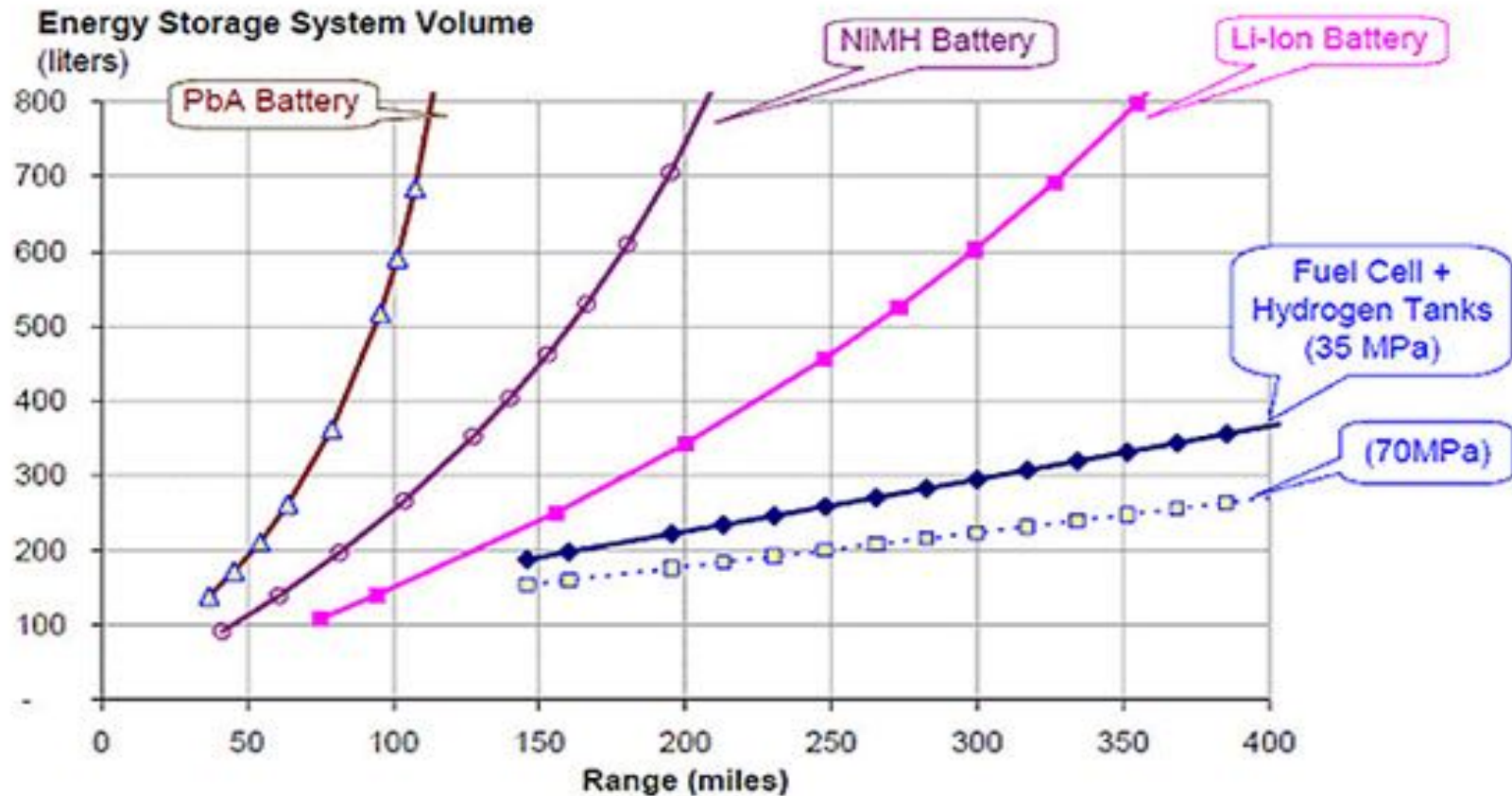
BATTERY TYPE COMPARISON



Note : Typical specific energy of lead-, nickel- and lithium-based batteries. NCA enjoys the highest specific energy; however, manganese and phosphate are superior in terms of specific power and thermal stability. Li-titanate has the best life span. **Source :** [Cadex](#)

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BATTERY TYPE COMPARISON



Note :

1. Driving range as a function of energy storage [1].
2. 35MPa hydrogen tank refers to 5,000psi pressure; 70MPa is 10,000psi.
3. [1] Source: International Journal of Hydrogen Energy, 34, 6005-6020 (2009)+

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BATTERY TYPE COMPARISON

S#	Description	LITHIUM-ION	LiFePO4	Hydrogen fuel cells
1	Energy Density Watt-hours/Kg	Highest	Good	Good
2	Cycle Life and Lifespan	Good (upto 5000 Cycles)	Best (5000 to 8000 Cycles)	Best (5000 to 10000 Cycles)
3	Speed	65 to 75 Km/h	75 to 90 Km/h	110 to 180 Km/hr
4	Km Range	160-200 Km	350 to 450 km	400 to 780 km
5	Qty of Charging	250 Kwh	480 Kwh	335-381 Kwh (extend:420Kwh)
6	Time of Charging	4 Hrs	5 Hrs	6 to 10 minutes
7	Type of Charging(Rapid/Normal)	Rapid/Normal Possible	Rapid Not Possible	Rapid/Normal Possible
8	Battery Changing Times	10 years = two times	10 years =Single Time	10 years =Single Time
9	Chemical & Thermal Stability	No Stable in Chemical and Thermal Stability	Stable Chemical and Thermal Stability	Stable Chemical and Thermal Stability
10	Thermal runaway and safe	Easily inflammable	No thermal runaway and safe when fully charged	No thermal runaway and safe when fully charged
11	Portability&lightweight characteristics	Best	Best	Best
12	Long life	Good	Best	Best
13	Low costs	Good	Best	Best
14	Recyclable	Not Possible	Can Recyclable	Recyclable done easily
15	Dust Formation	Easily inflammable	No problem	No problem

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4.ALTERNATE FUELS



EV Charging
Charging



CNG
Fuelling



LNG Fuelling
Gas Fuelling



LPG Fuelling
Propane
Fuelling



Hydrogen
Fuelling

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Exploring Sustainable Alternatives: A Response to Rising Diesel Costs in TNSTU

Considering the steep expenses associated with diesel, TNSTU ought to explore alternative fuel options. It's crucial to compile a list of substitutes for petroleum-based fuels that can be adopted in public transportation. The escalating prices of diesel necessitate a thoughtful examination of alternative fuel possibilities. This evaluation should encompass on the following for our current fleet..

- ❖ Economically competitive
- ❖ Technical acceptability for existing vehicles
- ❖ Environmentally acceptable
- ❖ Safety & availability.



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BENEFITS OF GOING ALTERNATIVE ENERGY SOURCES

- Conserve fossil fuels
- Slow climate change
- Reverse Climate Change
- Save lives
- Reduce severe weather
- Minimize Fuel dependency
- Economic & Job Development



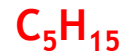
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WHY WE MOVE ALTERNATE FUELS & DRIVE SYSTEMS

DIESEL



PETROL



CNG



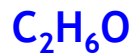
LNG



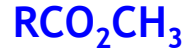
HYDROGEN



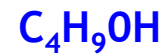
DME



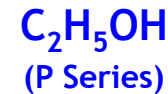
BIO-DIESEL



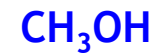
N-Butanol



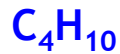
ETHANOL



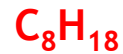
METHANOL



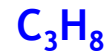
BUTANE



OCTANE



PROPANE



E-FUELS

e-kerosene,
e-methanol etc

CBG

(Mix of CH_4 +
 CO_2
+ H_2O + H_2S)

BIO- H_2

(Photo
fermentation)

BIO- CH_4

(Mix of CH_4 + CO_2
+ H_2O + O_2 + N_2 + H_2S)

AMMONIA



SOLAR

(PV-
Photovoltaic)

Note : e - Fuels are synthetic fuels produced from renewable raw materials such as maize, rapeseed, wheat and palm oil (e.g. bio-ethanol). **R*** - Fatty Acid. P- Indicates Methanol Percentage

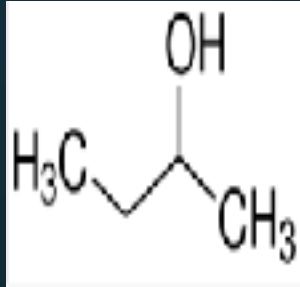
2. Diesel - Liquid methylnaphthalene (45 TO 55 Cetane), 3. Petrol - Mixture of Iso-octane & Heptane (91 TO 95 Octane) 4. Photo-fermentation reaction: $C_6H_{12}O_6 \rightarrow 6CO_2 + 12H_2$

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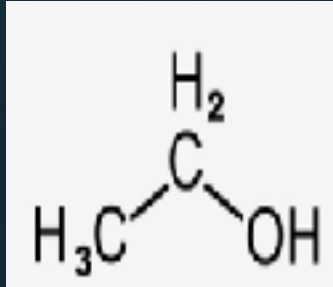
ALTERNATE FUELS OTHER THAN THE DIESEL IN INDIA



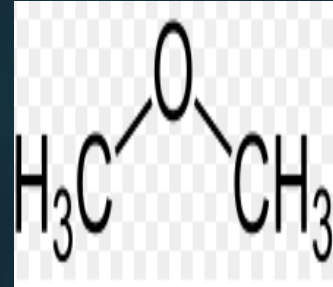
BIO DIESEL



BUTANOL



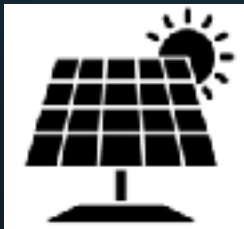
ETHANOL
(P SERIES FUELS)



DIMETHYL
ETHER (DME)



ELECTRIC



SOLAR



CNG



LNG



COMPRESSED
BIOGAS



HYDROGEN

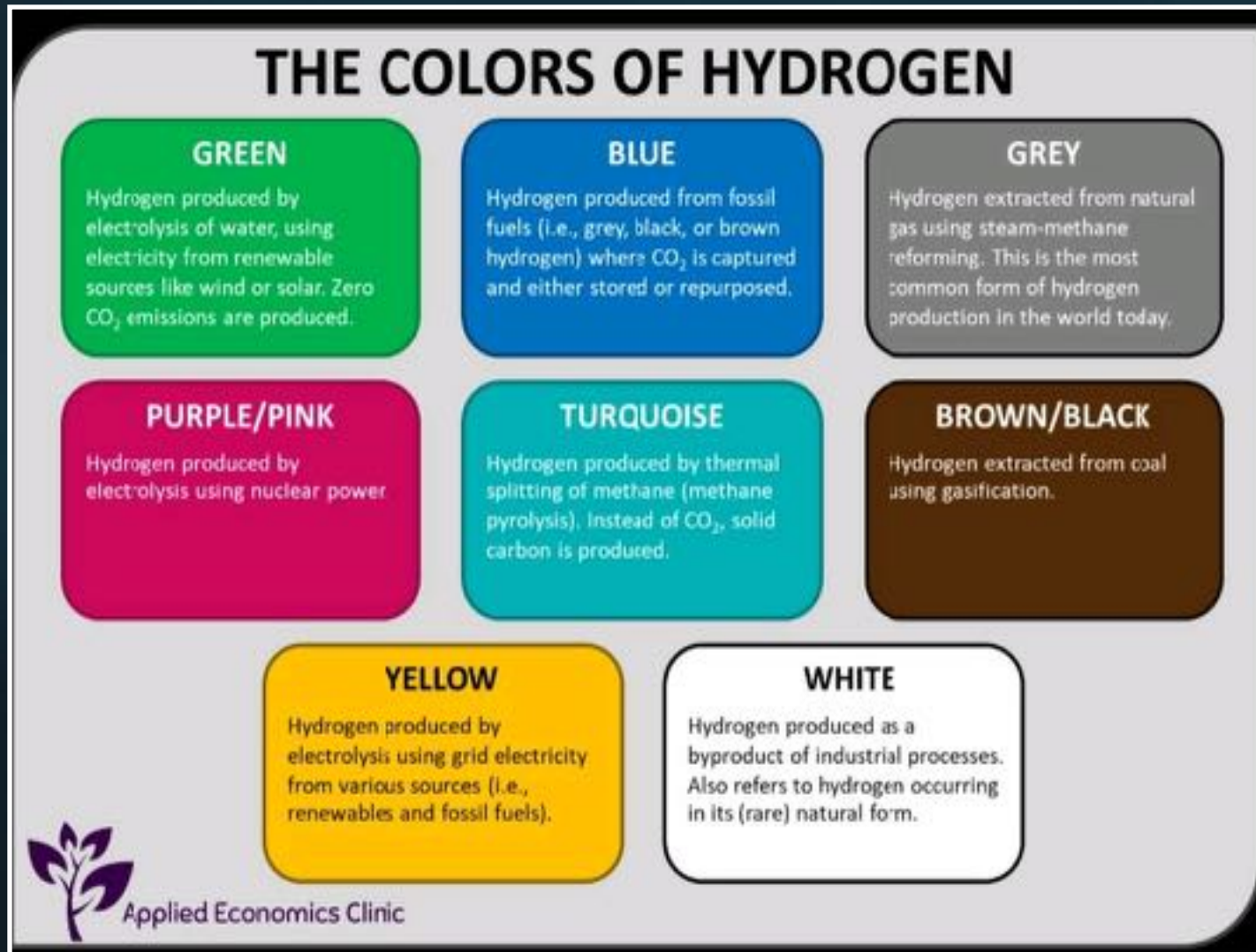
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2. HYDROGEN AS A FUEL & TECHNOLOGIES



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HYDROGEN GENERATION TYPES



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HYDROGEN COMPONENTS & SYSTEMS



**HYDROGEN
CHECK VALVE**



**FILLING
RECEPTABLE**



**TUBE & FITTINGS &
MANUAL BALL VALVE**

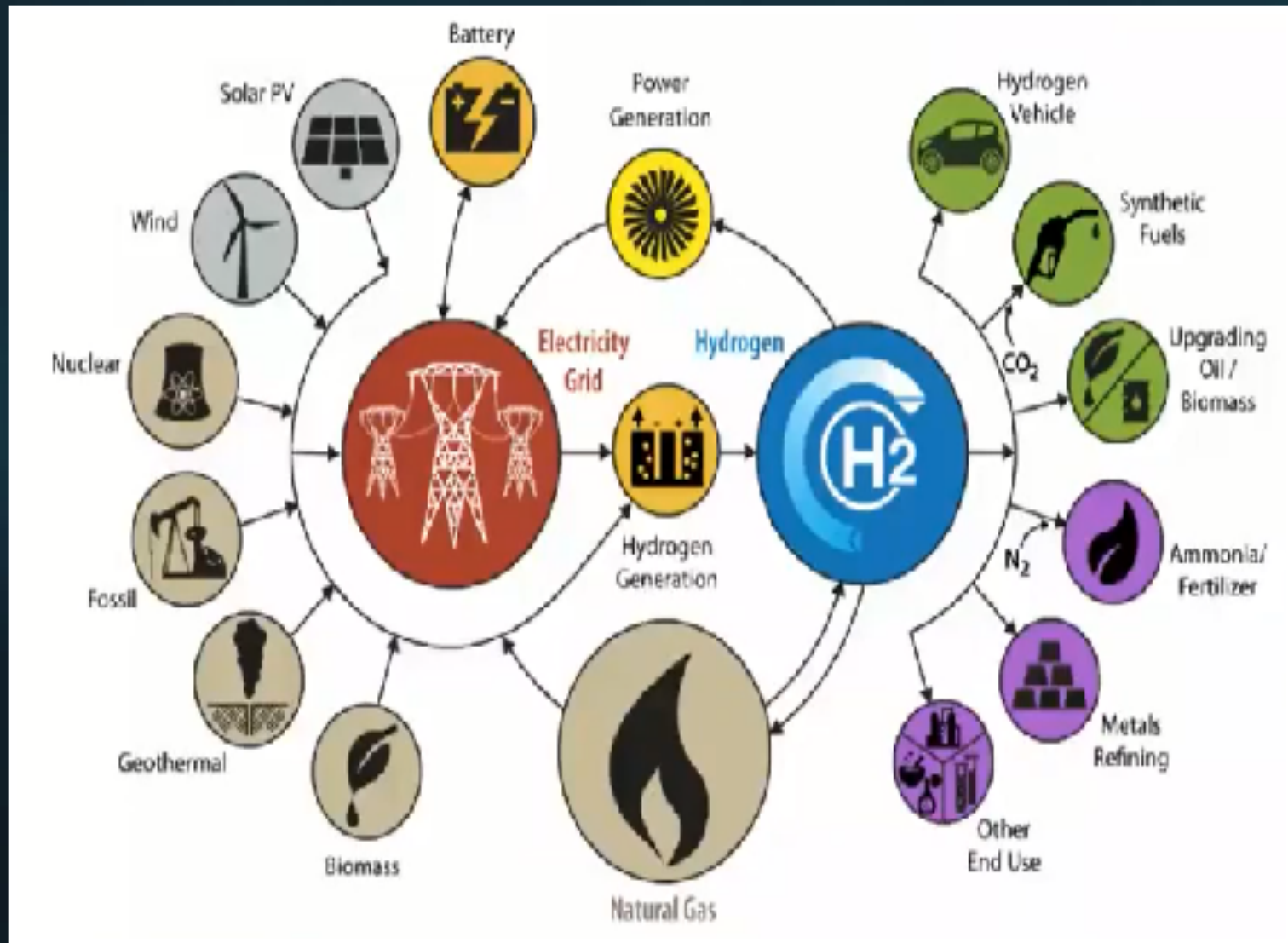


HYDROGEN TANK SYSTEM

Note : The hydrogen buses
save an estimated one
kilogram of CO₂ per
kilometre

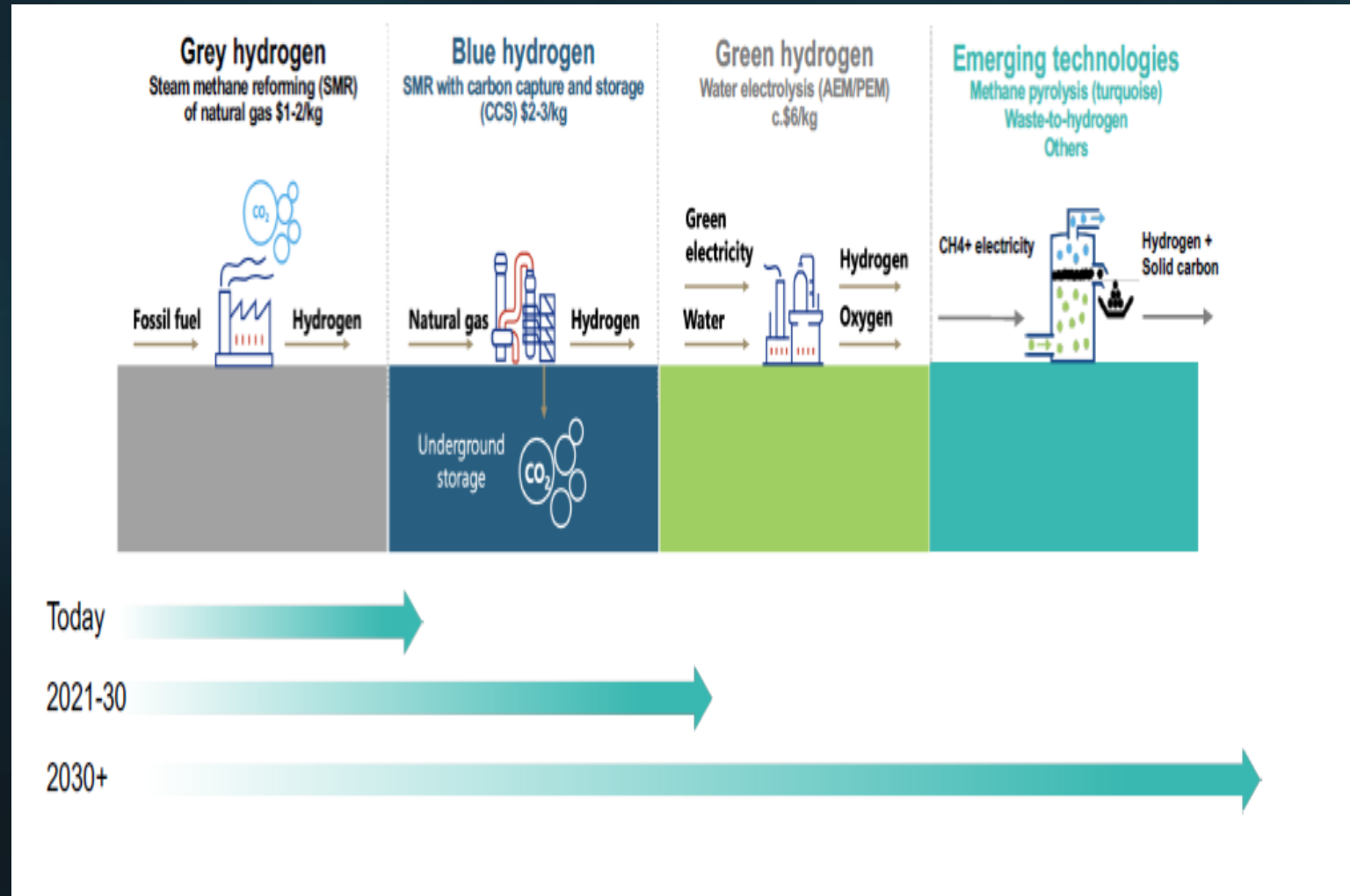
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HYDROGEN ENERGY TRANSFORMATION



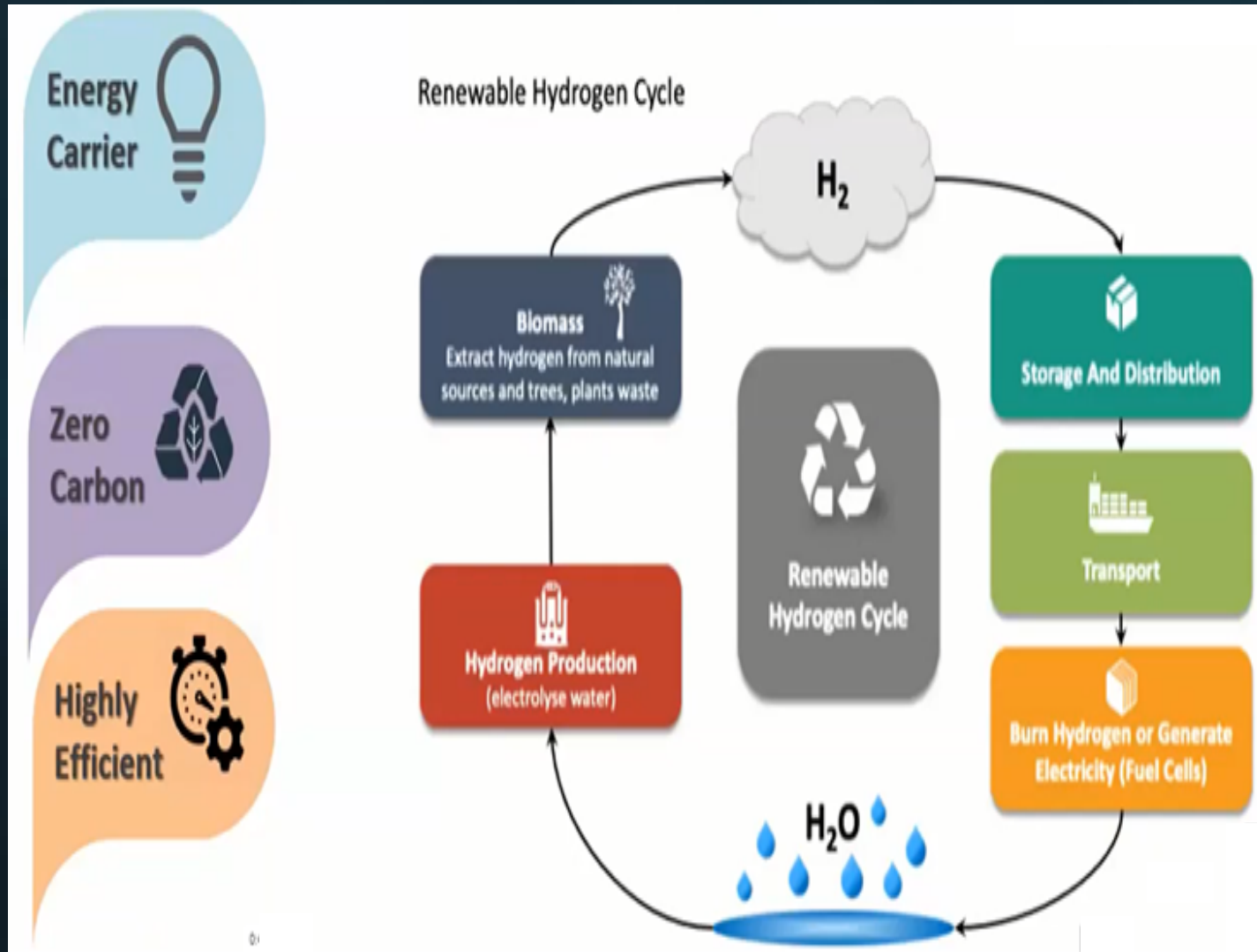
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HYDROGEN GENERATION TYPES



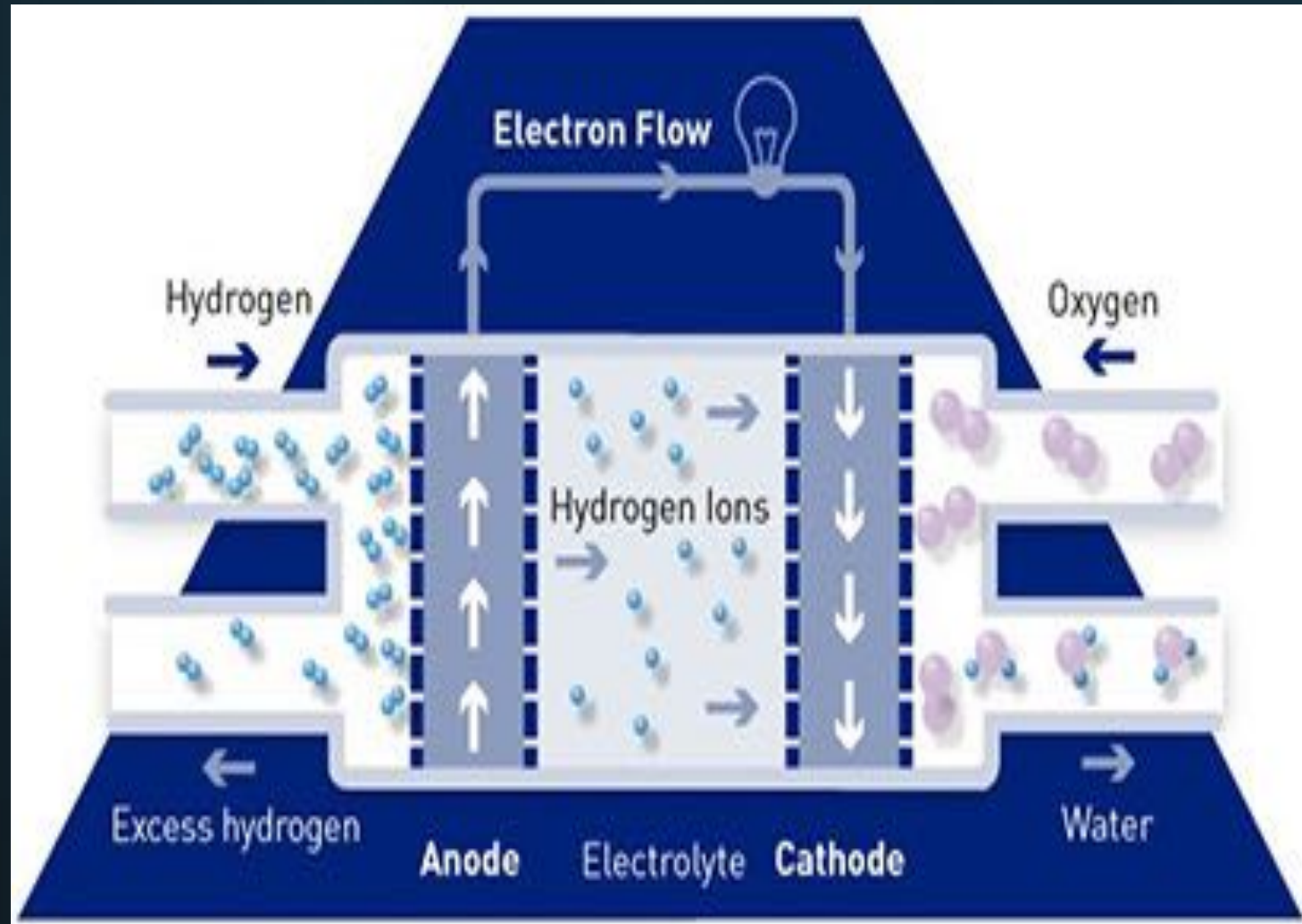
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RENEWABLE HYDROGEN AS A FUEL



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HOW A DIRECT HYDROGEN FUELCELL WORKS



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HYDROGEN + CNG FUEL BUS RUNNING IN DELHI



SOURCE: <https://www.businessworld.in/article/CNG-To-HCNG-Model-Capital-Intensive-Delhi-Govt-Unlikely-To-Scale-Up-Pilot-Project/30-09-2021-406749/>

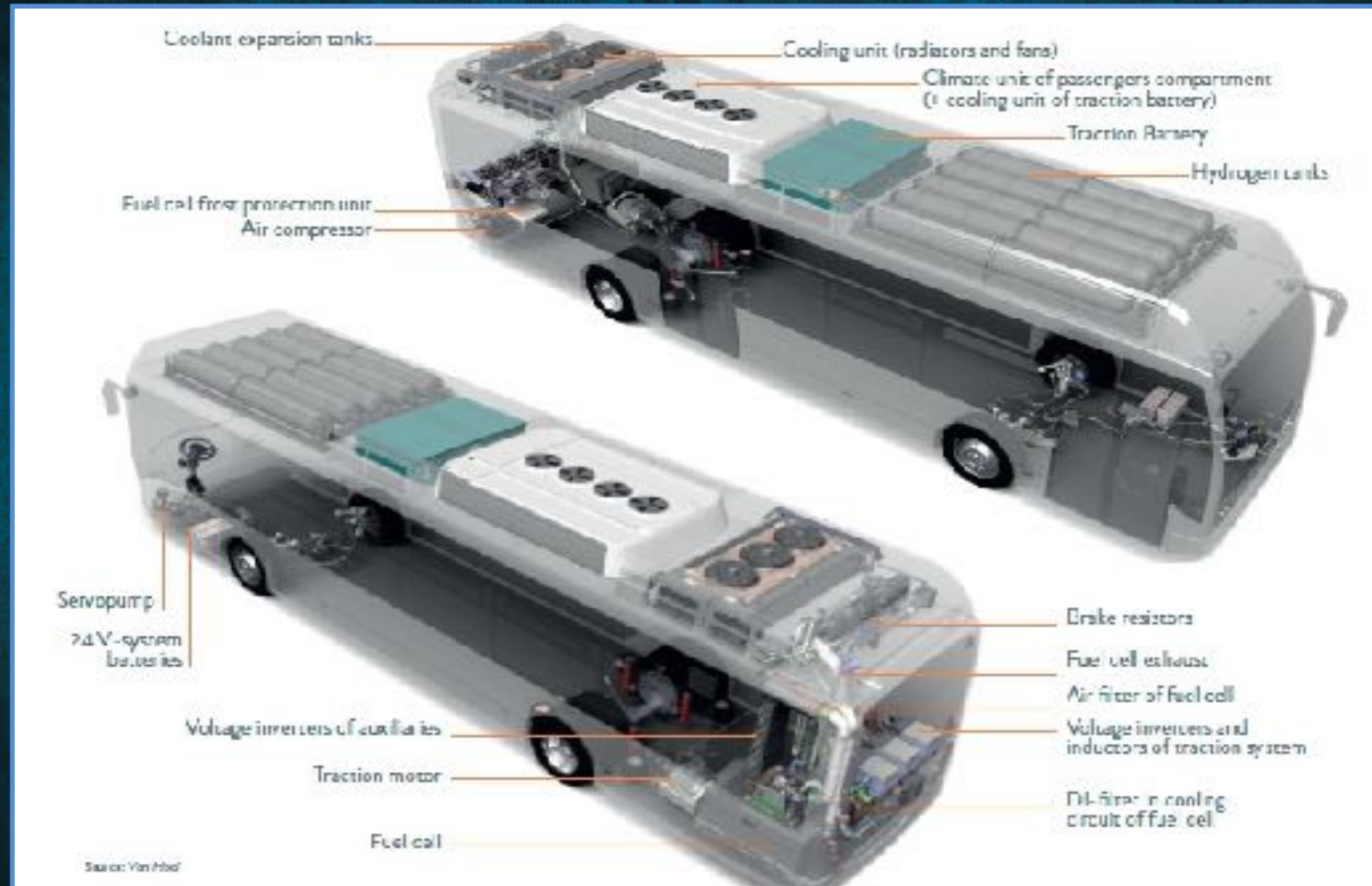
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HYDROGEN FUEL CELL BUS



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HYDROGEN FUEL CELL BUS



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BIO-DIESEL, CNG/LNG, CBG/RNG



BIO- DIESEL



CNG



LNG



DME



RNG

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BIO DIESEL RAW MATERIALS



Cottonseed Oil



Rapeseed Oil



Olive Oil



Palm Oil



Soy bean Oil



**Sunflower
Seed oil**



Peanut Oil



Linseed Oil



Safflower Oil



Used Cooking Oil



**Animal Fat
(Lard – Pork)
(Tallow – Beef)
(Schmaltz- Chicken)**

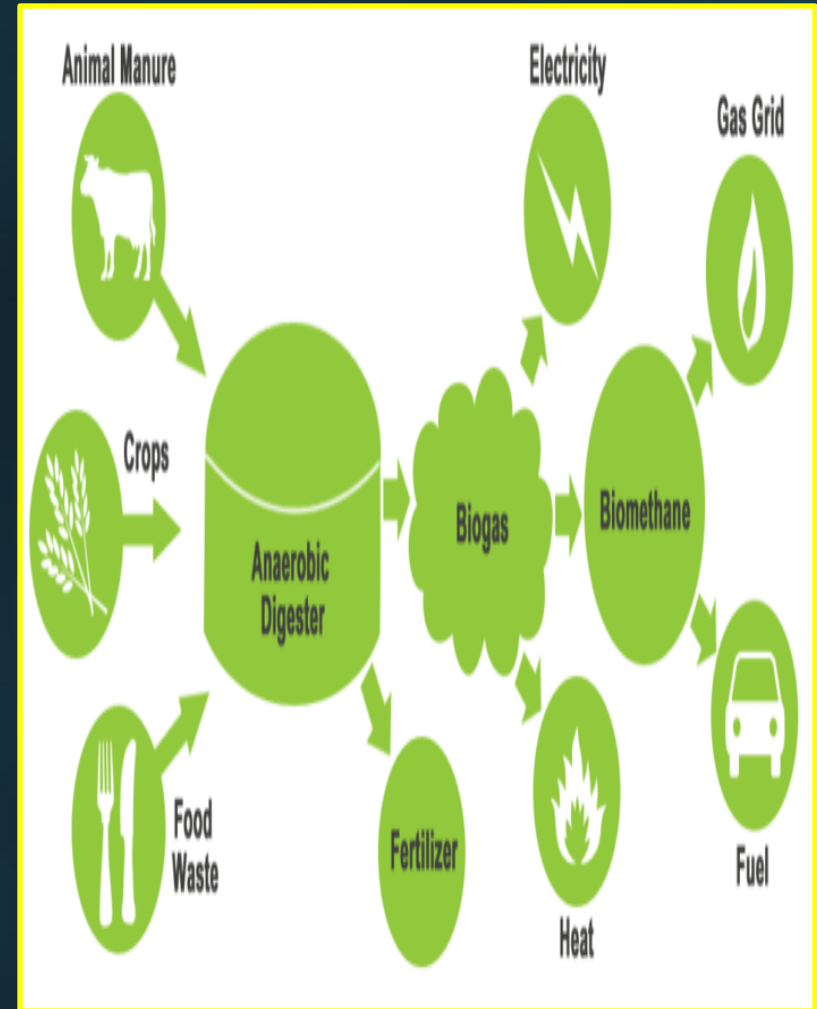
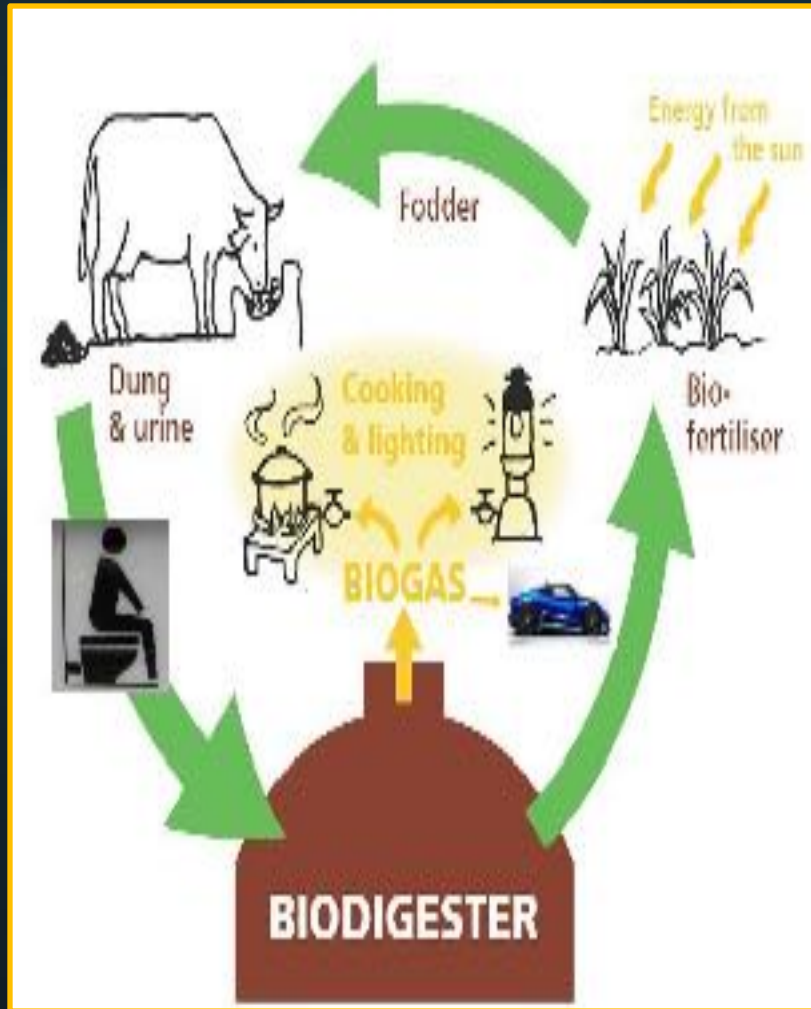
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COMPRESSED NATURAL GAS



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COMPRESSED BIO GAS



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DI METHYL ETHER



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COMPARISONS OF ALTERNATIVE FUEL DRIVE

IMPACT	Electric Drive	Hydrogen Drive	Hybrid Drive	Natural Gas (CNG)	LPG
+VE	No direct emissions	Zero emissions (no CO ₂ is produced)	More range than electric cars	Less emissions	Low-emission drive
	Zero CO ₂ while driving	Unlimited range (depending on tank filling)	No direct emissions for short journeys	Favourable alternative	Cost point
	Financial support from the government	Optimal with green electricity for production	Positive eco-balance especially in cities	Favourable tax treatment	
		Financially supported	Financially supported		
-VE	Good eco-balance only with "green" power source.	Energy-intensive production	Vehicles are heavier	Few filling stations	Higher consumption compared to petrol
	Problematic sources of raw materials for the production of the batteries	Few suitable infrastructure (e.g. filling stations) available	Less space in the boot	High conversion costs	By-product of crude oil & natural gas (= finite energy source)
	Comparatively heavy vehicles (weight) with limited range	Few models commercially available	Disposal problems of the lithium-ion battery	Transitional solution	
IMPACT	Organic Ethanol	Biodiesel	Vegetable Oil	E-Fuels	
+VE	Low-emission combustion	Better eco-balance than normal diesel	Low emission of fine dust	Synthetic fuels, from renewable raw materials	
	High engine power			Can also be produced from hydrogen	
				Potential for CO ₂ neutrality	
-VE	Competition with food cultivation	High nitrogen emissions	Modifications necessary	Competition with food cultivation - if obtained from natural raw materials.	
	Much energy needed for production	Energy intensive production	Often only suitable for old diesel	CO ₂ -neutral only if exactly as much CO ₂ is bound in the fuel as is consumed	
		Competition with food cultivation	Competition with food cultivation		

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TECHNOLOGIES & ALTERNATIVE FUEL FEASIBILITIES

Vehicle Type / Technology	Alternative Fuels											
	CNG	LPG	LNG	E10	E20	>E20	B7	M3	M15	M100	DME	Hydrogen
2Wheelers	X	X	X	OO	O	■	X	OO	O	X	X	X
Cars / UVs - SI	OO	OO	X	OO	O	■	X	OO	O	X	X	O
3Wheelers - SI	OO	OO	X	OO	O	■	X	OO	O	X	X	O
Buses	OO	X	O	X	X	X	OO	X	X	O	O	O
Trucks	X	X	O	X	X	X	OO	X	X	O	O	X
LCV's	OO	X	O	X	X	X	OO	X	X	O	O	X
Cars / UVs - CI	X	X	X	X	X	X	OO	X	X	X	X	X
3Wheelers - CI	X	X	X	X	X	X	OO	X	X	X	X	X
Legend:												
OO Technology Available, Feasible Fuel												
O Technology Needs development, feasibility to be established												
■ Technology Needs development, Feasibility of Fuel less due to availability												
X Not a Feasible fuel for the vehicle type												

SOURCE : SAE INDIA

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CLEAN FUEL TECHNOLOGIES

		Type of technology	Diesel	CNG	Biofuels	Biogas	BEV	FCEV
 Environmental	Decarbonisation (whole life cycle)		●	●	●	●	●	●
	Local air quality (tailpipe emissions)		●	●	●	●	●	●
	Noise reduction		●	●	●	●	●	●
 Economic	CAPEX		●	●	●	●	●	●
	OPEX		●	●	●	●	●	●
	Price-shock risk		●	●	●	●	●	●
 Operational	Energy efficiency		●	●	●	●	●	●
	Operational flexibility (fuelling)		●	●	●	●	●	●
	Technological risk		●	●	●	●	●	●
 Energy Management	Security of supply		●	●	●	●	●	●
	Transition risk		●	●	●	●	●	●
 City and public transport	City infrastructures		●	●	●	●	●	●
	Job creation		●	●	●	●	●	●
	Modernising customer offers		●	●	●	●	●	●

NOTE:

1.  High: Strong potential of achieving this benefit

2.  Medium: Possibility of achieving this benefit, according to local context, operational conditions and limits of the energy source

3.  Low: The benefit is not applicable or does not work well for this technology

SOURCE : UITP

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FUEL TECHNOLOGY COMPARISON

DESCRIPTION	DIESEL	BIO DIESEL	ELECTRIC	CNG	LNG	DME	H ₂	H ₂ FUEL CELLS
COST	NO	YES	YES	YES	YES	YES	YES	YES
DRIVING RANGE	YES	YES	YES	YES	YES	YES	YES	YES
FUEL AVAILABILITY	YES	YES	YES	YES	YES	NO	NO	NO
PAY LOAD	YES	YES	YES	YES	YES	YES	YES	YES
RELIABILITY	YES	YES	YES	YES	YES	YES	YES	YES
SERVICE LIFE	YES	YES	YES	YES	YES	YES	YES	YES
CLIMATE PROTECTION	NO	YES	NO	YES*	YES*	YES	YES	YES
POLLUTION CONTROL	NO	YES	YES	YES*	YES*	YES	YES	YES

SOURCE : SAE INDIA

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EMISSIONS FROM VARIOUS ALTERNATIVE FUELS

Fuel	PM	NO _x	THC	CO	Toxic Waste	Ozone Potential	Equ-CO ₂ GHG
Diesel	2.000	4.60	0.750	2.00	0.005	0.80	342.2
MeOH (NG)	0.035	2.25	0.275	0.50	0.05	0.65	400.9
CNG(Lean Burn)	0.050	3.00	1.200	0.35	0.00	0.40	285.5
CNG (Stoich)	0.025	1.40	0.730	1.00	0.00	0.40	302.2
EtOH(FromCorn)	0.050	5.00	0.500	0.50	0.05	0.80	229.1
LNG (Stoich)	0.025	1.38	0.730	1.00	0.00	0.40	499.7
H2DI(Steam)	0.025	3.00	0.000	0.00	0.00	0.10	389.0
PEM FuelCell(H ₂)	0.000	0.00	0.000	0.00	0.00	0.10	207.5
Pb-acid Bat-CNG	0.013	0.70	0.365	0.50	SO ₂	0.25	304.6
Pb-acid Battery	0.000	0.00	0.000	0.00	SO ₂	0.10	307.7
Pb-acid Battery / PEM- H ₂	0.000	0.00	0.000	0.00	SO ₂	0.10	257.2

SOURCE : SAE INDIA

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WHICH BUS IS ECONOMICAL EV/DIESEL FUEL BUS?

1	Generation of 1 Kwh electricity emits 950 gms of CO ₂
2	1 litre Diesel is equal to 840gms of Diesel
3	840gms of Diesel emit 2.68Kg of CO ₂
4	KMPL for Diesel is 5
5	1 litre Diesel emits = $2.68/5 = 0.536$ Kg of CO ₂
6	Electric Power Required for 100 Km (179 and 235 Kwh) = 1 to 1.4 Kwh
7	Electric Power emits CO ₂ 1.9Kg, where as diesel 0.60 Kg
8	Average 1.9 kg of CO ₂ emission per km for electric vehicle..where as diesel buses release .54 kg

??????

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Thank You

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5 WAYS TO REDUCE TRAFFIC EMISSIONS

S#	DESCRIPTION OF DO's		BENEFITS	QUANTITY
1		USE THE MOST EFFICIENT ENGINE: YOUR BODY! (Walking)	Healthy for you and the environment Can add up to +6 years of life expectancy	Reduce CO ₂ up to an avg. 116g/km compared to avg. car
2		MICRO MOBILITY, MACRO BENEFIT! 100% flexibility. (Cycling)	No parking space, No problem	E-scooters can save 27.5% avg. CO ₂ per km compared to replaced mode
3		WITHOUT REGRETS USE PUBLIC TRANSPORT!	7 times Higher fuel efficiency Risk of fatalities with bus -15x and risk of fatalities with train -78x	40 cars made obsolete just by one bus
4		DON'T MAKE PARKING THE MAIN PART OF YOUR JOURNEY! (PARKINGHUBS)	Parking wastes thousands of hours and huge amounts of fuel, negatively affecting air quality and health.	30% of urban road emissions come from cruising for parking
5		TECHNOLOGY CREATES ARTS! (ITS)	ITS have the capability to create harmony between pedestrians, cyclists, public transport & drivers.	save extra 20% of CO ₂