

## UNIT-3

# ENERGY ALTERNATIVES AND GREEN CAREERS TOPICS

- Fossil Fuel Dependence and Decentralized Energy Systems
- Hydrogen as a future fuel and its environmental implications
- Biofuels and their Ecological Trade-offs
- Electric vehicles (EVs): environmental impact
- AI/ML in environmental prediction
- Smart and Sustainable agriculture
- Green computing

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# Fossil Fuel Dependence

The term fossil fuel dependence refers to the over-reliance on coal, oil, and natural gas to meet the world's energy needs. Fossil fuels are natural, combustible materials formed over millions of years from the fossilized remains of ancient plants and animals. These fuels are non-renewable and are the main contributors to greenhouse gas emissions.

## Types of Fossil Fuels

1. Solid e.g., Coal,
2. Liquid e.g., Oil (Petroleum)
3. Gas e.g., Natural Gas



coal



Petroleum



Natural  
gas

## Advantages

- High energy density (small amount gives large energy).
- Established infrastructure (refineries, pipelines, power plants).
- Reliable and continuous supply (base-load power).
- Low cost compared to some renewable sources (currently in many regions)

## Disadvantages of Fossil Fuels

- **Environmental impact:** Air pollution, global warming, acid rain, Climate change, Land degradation due to mining, Oil spills cause soil and water pollution, and natural gas leaks.
- **Finite resources:** Non-renewable, reserves are depleting.
- **Economic risks:** Price fluctuations in global markets.
- **Geopolitical tensions and Energy insecurity:** Many countries depend on imports (e.g., oil from Middle East).
- **Health impacts:** Mining and burning fossil fuels cause respiratory and heart diseases.

# Decentralized Energy Systems

Decentralized (or distributed) energy systems are small-scale power generation technologies located close to the point of use (homes, communities, industries), reducing reliance on large, centralized power plants.

## Solar



Uses sunlight to generate electricity. Clean, abundant, and works best in sunny not available during night and cloudy days.

## Wind



Small or medium wind turbines generate electricity from wind flow. Provides clean power but is weather-dependent.

## Biomass



Biomass & Biogas uses agricultural waste, animal dung, or organic leftovers to produce energy. Biomass can be burned for heat/electricity, while biogas can be used for cooking or power.

## Hydro



Hydropower plants generate electricity from flowing rivers or streams. Reliable, renewable and provides community-level electricity.

**Decentralized Energy:** energy produced near the point of use, rather than at a large, central plant. **Distributed Energy:** that can operate independently or together to provide power.

## Limitations of Decentralized Energy

1. **High Initial Cost**
2. **Intermittency**
3. **Need for Storage Systems**
4. **Technical Expertise**

## Advantages of Decentralized Energy

1. **Sustainability** – do not harm the environment.
2. **Energy Security** – Reduces dependence on imported fossil fuel
3. **Efficiency** – less electricity is lost during transmission.
4. **Resilience** – Microgrids and local systems keep power running even in disasters.
5. **Community Empowerment** – Local people can own and manage small power systems
6. **Scalability** – Small projects can start in villages or towns and expand gradually

## Solutions for Transition

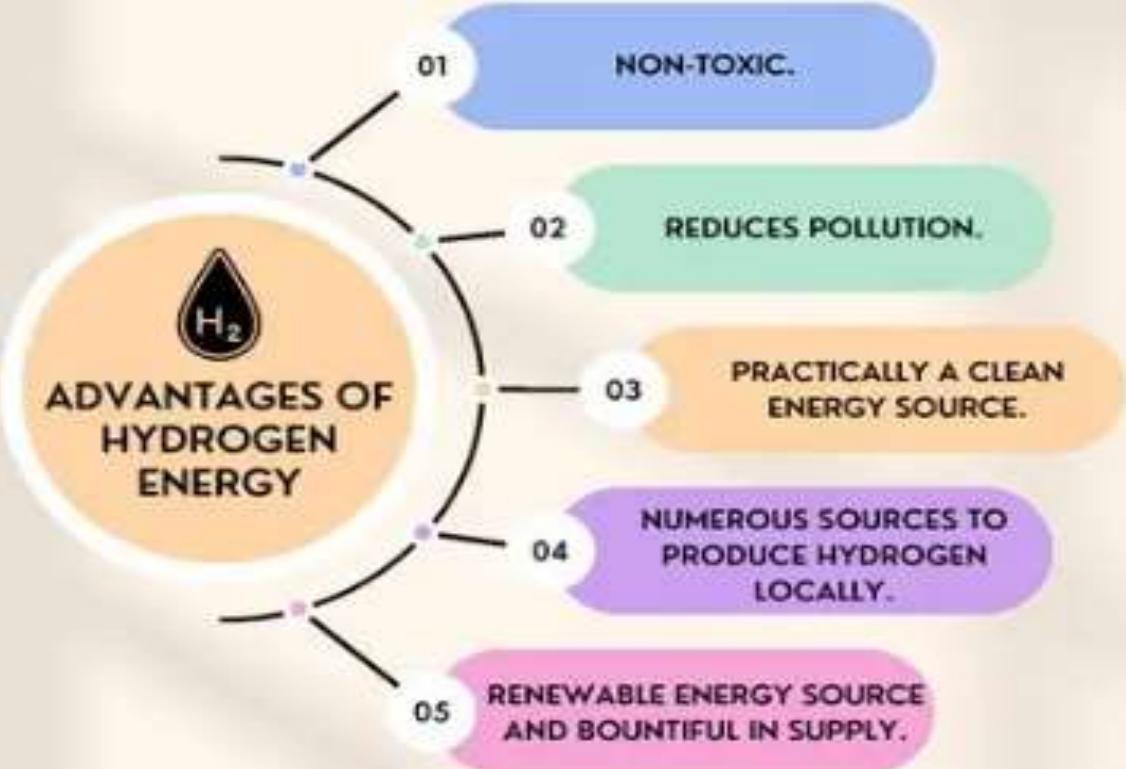
1. **Policy Support**
2. **Technological Advancements**
3. **Community Involvement**
4. **Diversification of Energy Mix**
5. **International Cooperation**

# Fossil Fuel Vs Decentralized Energy Systems

Aspect	Fossil Fuel Dependence	Decentralized Energy Systems
<b>ENERGY SOURCE</b>	Coal, oil, natural gas (nonrenewable)	Solar, wind, biomass, hydro (renewable)
<b>AVAILABILITY</b>	Limited, depleting	Abundant, sustainable
<b>POLLUTION</b>	High CO <sub>2</sub> and other emissions	Very low emissions
<b>INFRASTRUCTURE</b>	Well-developed but centralized	Growing, flexible, community-based
<b>RELIABILITY</b>	Reliable but unsustainable long-term	Can be intermittent, but resilient with storage
<b>COST</b>	Often cheaper now but volatile	Higher initial cost, but falling rapidly
<b>SECURITY</b>	Import-dependent, prone to conflicts	Local control, less geopolitical risk



# Hydrogen as a future fuel



TWINERADAN



# Hydrogen fuel: Types Advantages and Limitations

Name	Description	Advantages	Limitations
Green Hydrogen	Produced by electrolysis of water using renewable energy (solar, wind, hydro).	100% renewable and sustainable, zero direct CO <sub>2</sub> emissions, best long-term solution for climate goals, can decarbonize hard-to-abate sectors (steel, transport, aviation).	Requires abundant renewable energy and water, high cost
Blue Hydrogen	Made from natural gas with carbon capture and storage (CCS).	Cleaner than grey (with CCS), transitional fuel toward green hydrogen, can reuse existing natural gas infrastructure	CCS is expensive and not 100% effective; still fossil-based.
Purple Hydrogen	Electrolysis powered by nuclear heat. Pink hydrogen(electrolysis powered by nuclear electricity).	Efficient high-temperature production, suitable for industrial applications	Nuclear waste concerns; public resistance; infrastructure cost.
Grey Hydrogen	Produced from natural gas by steam methane reforming (SMR) without carbon capture.	Cheapest and most established method, large-scale production possible, strong existing infrastructure.	High CO <sub>2</sub> emissions; most common but least sustainable.
Turquoise Hydrogen	Created by methane pyrolysis, yielding hydrogen and solid carbon (carbon black).	Produces solid carbon instead of CO <sub>2</sub> (easier to handle), can use existing natural gas supplies	Emerging technology; still relies on fossil fuels; energy-intensive.

Steam methane reforming (SMR) is a widely used method for producing hydrogen by reacting methane with steam, resulting in syngas (hydrogen and carbon monoxide) that can be further processed.

## **Role of Hydrogen in Green Energy Mission of India**

**National Green Hydrogen Mission (NGHM), India aims to produce**

- 5 million metric tonnes annually by 2030
- Addition of about 125 GW in the country by the year 2030.
- Creating over 600,000 jobs.
- Reduce dependence on imported fossil fuels
- Enhance energy security
- Positioning itself as a global hub for green hydrogen production and export accelerating its path toward net-zero emissions by 2070.



### **Key Disadvantages**

- 1.High Production Costs**
- 2.Storage and Transportation Challenges**
- 3.Safety Concerns**
- 4.Infrastructure Limitations**
- 5.Dependence on Fossil Fuels for Production**
- 6.Limited Availability of Raw Materials:**

**Memorandum of Commitment (MoC) of Himachal Government with Chandigarh-based Spray Engineering Devices Ltd**

**Leh is the first city in India to introduce hydrogen fuel cell buses for public transport, 25 June 2025**

#### **Recent Posts**

- Himachal Signs MoC for developing India's First Integrated Active Pharmaceutical Ingredients (API), Green Hydrogen, and 2G Ethanol Plant
- Hero Future Energies launches green hydrogen plant in Tirupati
- Indian Railways to Introduce First Hydrogen Train on Jind-Sonipat Route

- India has power output of 1,200 horsepower
- Germany, France, Sweden, and China run hydrogen-powered trains of 500-600 horsepower

# Biofuels

Biofuels are renewable fuels derived from biomass such as plants, algae, and organic waste. They are considered an alternative to fossil fuels because they reduce dependence on non-renewable energy sources and can contribute to carbon neutrality.



## 1<sup>st</sup> Generation Biofuel

- It has High Carbon Content.
- Made from Edible Items. Eg- Sugar, Corn, Starch etc.



## 2<sup>nd</sup> Generation Biofuel

- Greenhouse Gas content less than 1<sup>st</sup> Generation Biofuel
- Made from leftover of Food Crops. Eg- Rice Husk, Wood Chips etc.



## 3<sup>rd</sup> Generation Biofuel

- It is Carbon Neutral in. (CO<sub>2</sub> Emitted = CO<sub>2</sub> Sequestered)
- Produced using Microorganisms. Eg. Algae



## 4<sup>th</sup> Generation Biofuel

- Made from 'Genetically Engineered Crops'.
- They are Carbon Negative.



## EXAMPLES

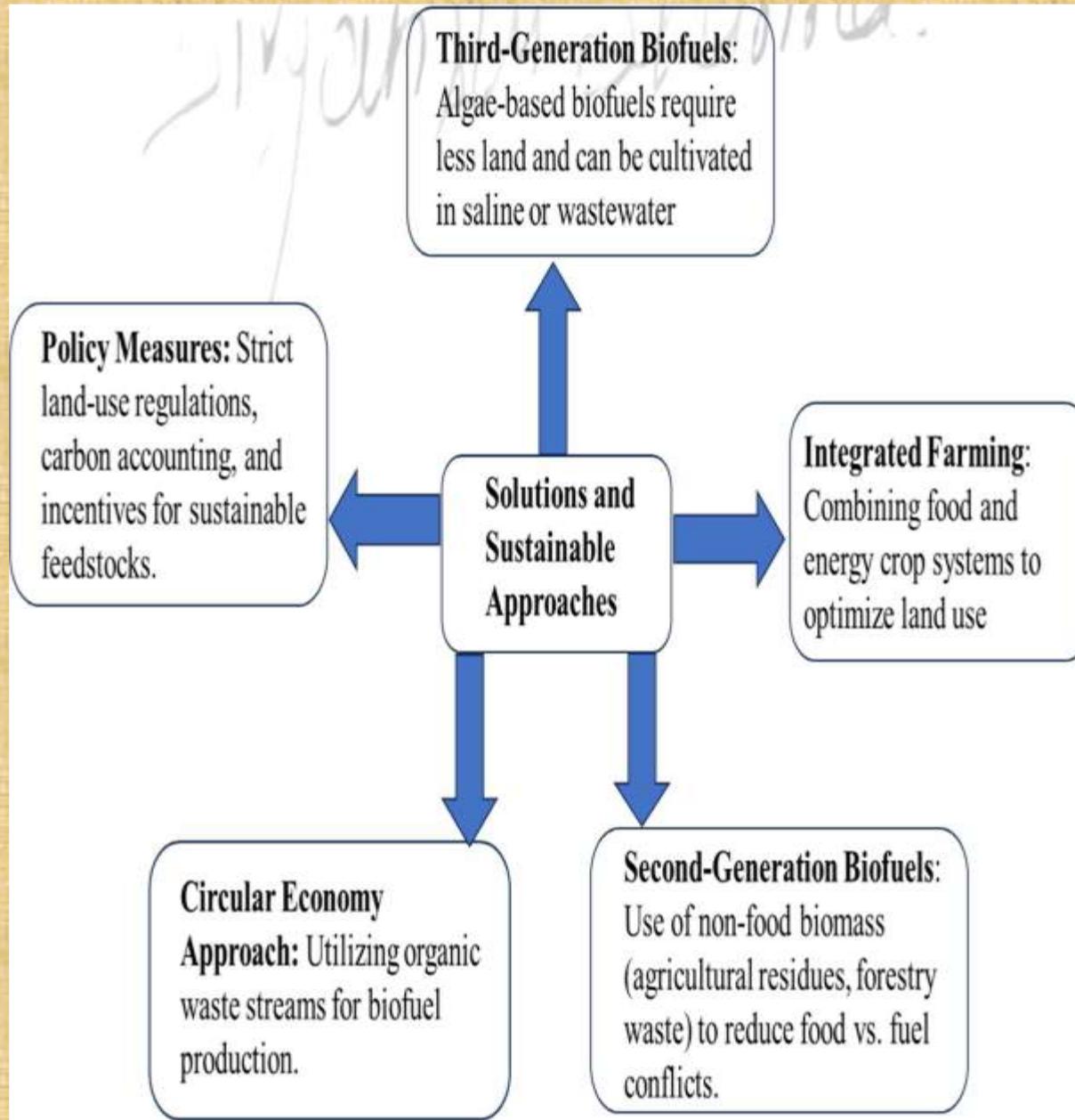
- 1<sup>st</sup>: Bioethanol, Biodiesel
- 2<sup>nd</sup>: Cellulosic ethanol, Fischer–Tropsch diesel
- 3<sup>rd</sup>: Algal biodiesel, Algal bioethanol
- 4<sup>th</sup>: Biofuels from genetically modified algae or cyanobacteria

# Ecological Trade-offs of biofuel

Biofuels are eco-friendly alternatives to fossil fuels, their large-scale production can also harm ecosystems, so the term Ecological Trade- offs refers as a give-and-take relationship between their advantages and environmental costs. Biofuels hold promise as a renewable and relatively clean energy source.

Benefit of biofuels	Ecological Trade-off
Reduced CO <sub>2</sub> and greenhouse gas emissions	Deforestation and loss of biodiversity (when forests are cleared for biofuel crops).
Renewable and sustainable energy source	High water demand for feedstock cultivation (e.g., sugarcane, corn)
Utilization of agricultural/industrial waste	Soil nutrient depletion, if residues are not returned to the soil.
Boosts rural economy and farmer income	Food vs. fuel conflict when food crops are diverted to biofuel.
Biodegradable and less toxic than fossil fuels	Fertilizer and pesticide pollution from intensive monoculture and crop yield.
Energy security and reduced fossil fuel dependence	Carbon debt from converting forests/peatlands into farms

# Solutions and Sustainable Approaches



## RECOMMENDATIONS

**Policy Integration:** Aligning policies across sectors can create a supportive environment for biofuel development.

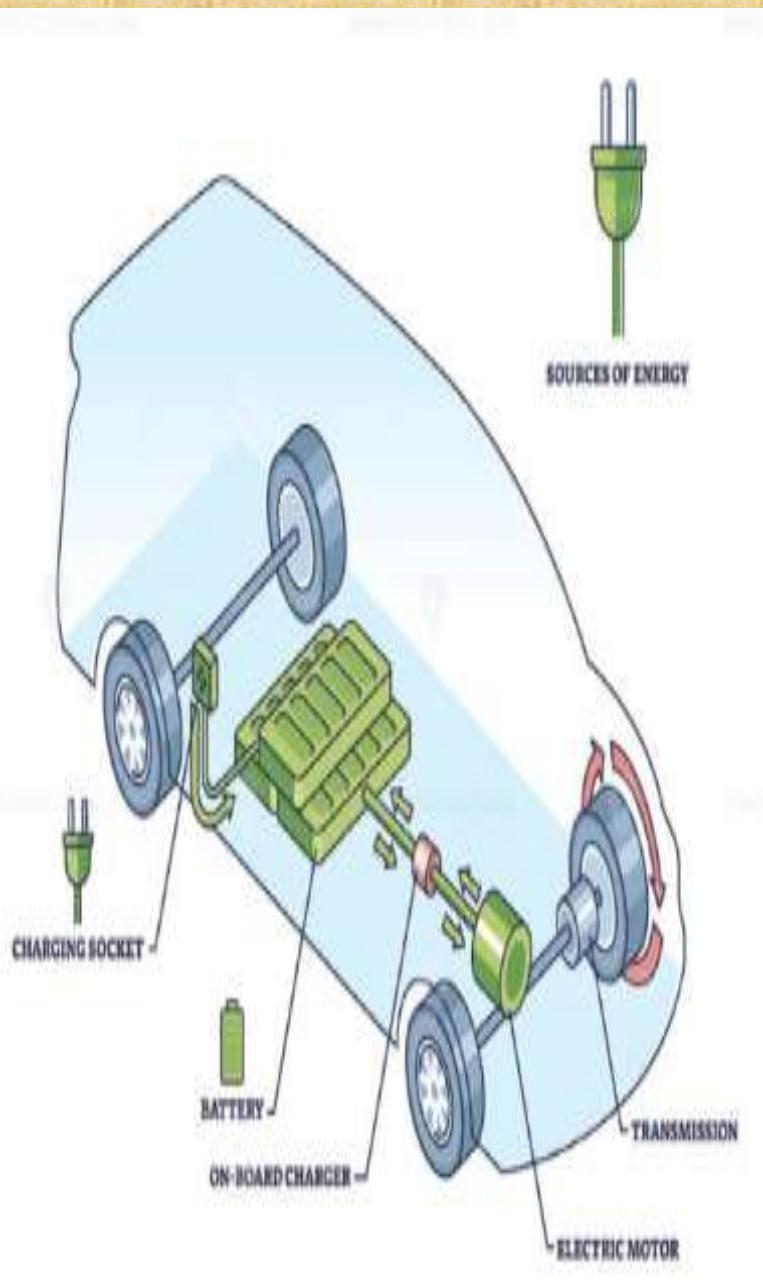
**R&D Investment:** Prioritizing research on second and third-generation biofuels can bridge technological gaps.

**Collaborative Innovation:** Partnerships between industry and academic institutions can drive innovation and address socio-economic implications.

## INDIA: Current Biofuel Landscape

- **500 million tons** (approx.) of biomass available annually, with 120 to 150 million tons surplus for energy production.
- Biofuels contribute about **12.83% of total renewable energy generation**, highlighting their significance in reducing dependence on fossil fuels.
- Major public sector undertakings, such as **Indian Oil Corporation (IOC)** and **Bharat Petroleum Corporation Limited (BPCL)**, are investing heavily in biofuel research and production.
- Initiatives like the **Pradhan Mantri JI-VAN Yojana** encourages private sector participation in sustainable aviation fuel and second-generation biofuel production.

# ELECTRIC VEHICLE: ENVIRONMENTAL IMPACT



"NITI Aayog reported that by transitioning to electric mobility, India can

- reduce carbon dioxide emissions by 37% by 2030,
- save \$60 billion in energy costs,
- eliminate up to one gigaton of emissions over a 15-year period".

Electric vehicles are powered by electric motors that get energy from rechargeable batteries. Unlike regular vehicles that burn fuel and emit harmful gases, EVs use electricity which results in no exhaust smoke.

## Main Parts of an Electric Vehicle

**Battery:** The battery (usually lithium-ion) is the energy storage unit that supplies electricity required by the motor.

**Electric Motor:** This component converts electricity stored in the battery into mechanical energy to turn the wheels.

**Charge Port:** The charge port is the area on the vehicle where the plug connects to charging equipment.

**Controller & Transmission:** The controller regulates the power flow between battery and motor as per driver inputs (accelerator/brake). It manages speed, torque, and safety.

# Types of Electric Vehicles

## Battery Electric Vehicle (BEV)

They are fully electric and operate only by battery and electric motor; they produce no tail-pipe émissions e.g., Tata **Nexon EV**

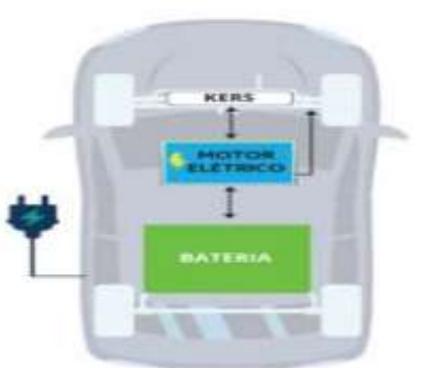


**BEV**

BATTERY ELECTRIC

**BEV**

Battery Electric Vehicle



## Hybrid Electric Vehicle (HEV)

It has a internal combustion engine with an electric motor and battery; both sources can power the vehicle e.g., **Toyota C-HR Hybrid**

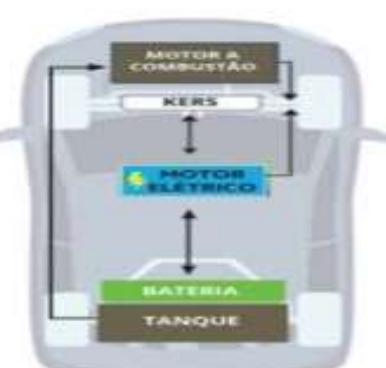


**HEV**

HYBRID ELECTRIC

**HEV**

Hybrid Electric Vehicle



## Mild Hybrid Electric Vehicle (MHEV)

Similar to HEV but with a smaller battery and electric motor e.g., **Nissan Qashqai DIG-T MHEV**

**MHEV**

Micro Hybrid Electric Vehicle



## Fuel Cell Electric Vehicle (FCEV)

FCEVs generate electricity using a fuel cell that combines hydrogen gas with oxygen from the air; the only emission is water vapor e.g., **Toyota Mirai**

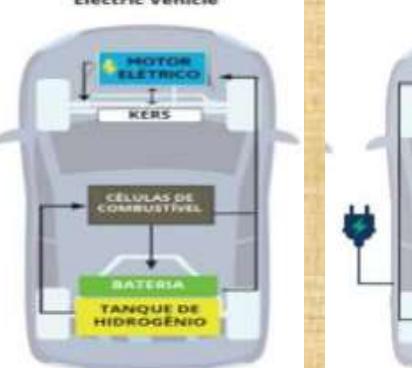


**FCEV**

FUEL CELL ELECTRIC VEHICLE

**FCEV**

Hydrogen Fuel Cell Electric Vehicle



## Plug-in Hybrid Electric Vehicle (PHEV)

PHEVs use rechargeable batteries and a conventional engine. It has two types, parallel type is usually just referred to as PHEV, while the series variation can be referred to as **extended range electric vehicles (EREV)**. PHEV use rechargeable batteries and a conventional engine while EREVs have a gasoline generator that can provide electricity to the electric motor and batteries e.g., **Hyundai Ioniq PHEV**



**PHEV**

Plug-In Hybrid EV



**E-REV**

Extended Range Electric Vehicle



**PHEV**

PLUG-IN HYBRID ELECTRIC VEHICLE



**EREV**

EXTENDED RANGE ELECTRIC VEHICLE

## Electric Vehicle

### Positive Impact

- Eco-Friendly as no exhaust smoke, reduces air pollution.(Good for cities like Delhi with smog problems.)
- Cheaper to Run as electricity costs less than petrol/diesel.
- Low Maintenance due to fewer moving parts, no oil changes.
- Silent Ride due to less noise pollution, smoother driving.
- Energy Efficient as it converts more of the battery's energy into motion compared to fuel engines.
- Supports Renewable Energy if it can be charged with solar/wind energy.
- Government Support that Subsidies, tax benefits, and incentives for EV buyers.

### Negative Impact

- High Price as EVs cost more initially than petrol/diesel cars.
- Limited Range as most EVs can run only 150–400 km per charge (improving slowly).
- Charging takes longer to recharge compared to quick fuel filling.
- Charging Stations is not available everywhere, especially in rural areas.
- Batteries are expensive to replace; performance drops after years.
- If electricity comes from coal power, pollution shifts from road to power plant.
- Less Choice as fewer models available compared to petrol/diesel cars.

Under the PM E-DRIVE scheme, more than one million EVs were sold in FY 2024-25, marking a significant lean toward a cleaner environment

- Provide financial incentives
- Take assistances from both public and private sectors to build more charging stations.
- Utilize mass media and online advertisements to create public awareness.
- Provide proper user manuals and free safety check for new purchases



- Highly expensive.
- Adoption is still limited
- Public awareness and knowledge are very limited.
- Safety and health risks are unknown to public.

### Society

- Implement effective battery recycling methods using AI.
- Implement IoT-enabled sensors to deploy for the monitoring of noise levels and air quality.
- Support R & D to find alternative nontoxic raw materials.
- Eliminate ecologically sensitive locations.



- Energy wastage due to battery's limited life.
- Potential air and noise pollution.
- Extraction of hazardous materials.
- Massive land usage.
- Difficult to design sustainable business models.
- Huge finances required to update current grids.
- Disruption of employment.
- Reduction in fuel tax revenues.

### Economical Recommendations

- Implement industrial collaborations and training for academic institutions.
- Develop grid compatible charging infrastructures.
- Provide services like value-added services, loyalty programs, and premium charging experiences.
- Examine models of congestion pricing and encourage public-private funding initiatives.



# Electric Vehicles: Environmental Impacts

Extraction of every tonne of lithium requires 5,00,000 LITRES OF WATER



Manufacturing EVs is about **50% MORE** water-intensive than ICE

EV is almost twice as environment-unfriendly as an ICE-car

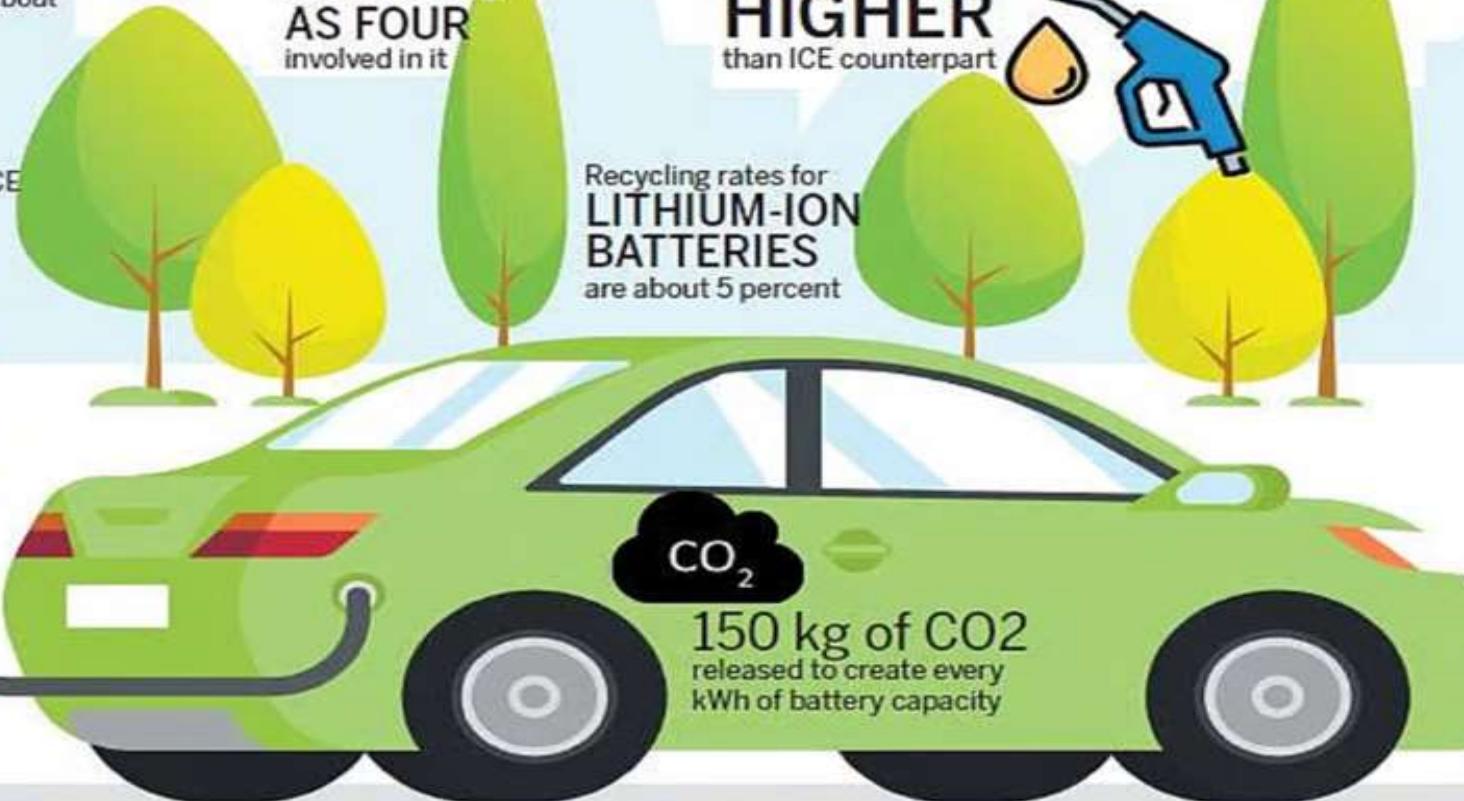
An EV vehicle needs a battery capacity of 60kWh

The batteries emit toxic fumes, if damaged

India currently IMPORTS ALL OF ITS LITHIUM from Australia and Argentina



Cobalt mining is akin to modern-day slavery with **CHILDREN AS YOUNG AS FOUR** involved in it



An additional electricity generation of **3,000 terawatt hours** would be needed to fuel the rising demand of EVs

EVs currently priced

**25-35% HIGHER** than ICE counterpart

Recycling rates for **LITHIUM-ION BATTERIES** are about 5 percent



**98%** of the batteries end up in **LANDFILLS**

The battery comprises mined materials, including **LITHIUM, NEODYMIUM, COPPER, COBALT, ALUMINIUM, NICKEL, MANGANESE AND GRAPHITE**. Some of these are available only in a few countries.

The process of mining, refining and transportation adds to **GREENHOUSE GASES**

The net negative impact of EVs today is greater for coal-intensive countries like India

# AI/ML IN ENVIRONMENTAL MONITORING

**Artificial Intelligence (AI):** includes designing systems that can perform tasks requiring human intelligence. These tasks include learning, reasoning, problem-solving, understanding language, and making decisions. AI systems work by analyzing data, finding patterns, and improving their performance over time without being programmed for every new task. AI can be categorized into:

**Narrow AI:** Specialized systems designed for specific tasks (e.g., Siri, chatbots).

**General AI:** Hypothetical systems with human-like intelligence across various tasks (*IBM's Watson*, an AI system that gained recognition for its ability to defeat human contestants on the game show “Jeopardy!” and *DeepMind’s AlphaGo*)

**Super AI:** A theoretical form of AI that surpasses human intelligence in all aspects including creativity, decision-making and problem-solving

**Machine Learning (ML):** is a part of AI that focuses on helping computers learn from data. Instead of step-by-step instructions, ML algorithms study data, find patterns, and use them to make predictions or decisions e.g., ML can study past data on temperature or pollution to predict future trends. Types of ML include:

**Supervised learning** – learning from labelled data.

**Unsupervised learning** – finding hidden patterns.

**Reinforcement learning** – learning through feedback.

# Role of AI and ML in monitoring and prediction

## AI for Climate Monitoring and Mitigation

- Climate Change Tracking and Prediction
- Optimizing Renewable Energy Generation
- AI in Solar Energy Optimization
- AI in Wind Energy Management
- AI in Hydropower Optimization

## AI for Biodiversity and Wildlife Conservation

- Species Monitoring and Poaching Prevention
- Habitat Protection and Ecosystem Monitoring
- Managing Human-Wildlife Conflict

## Pollution Control and Waste Management with AI

- Air Quality Monitoring and Management
- Addressing Crop Residue Burning
- Waste Management and Circular Economy
- Recycling and Resource Recovery

## Water Resource Management through AI

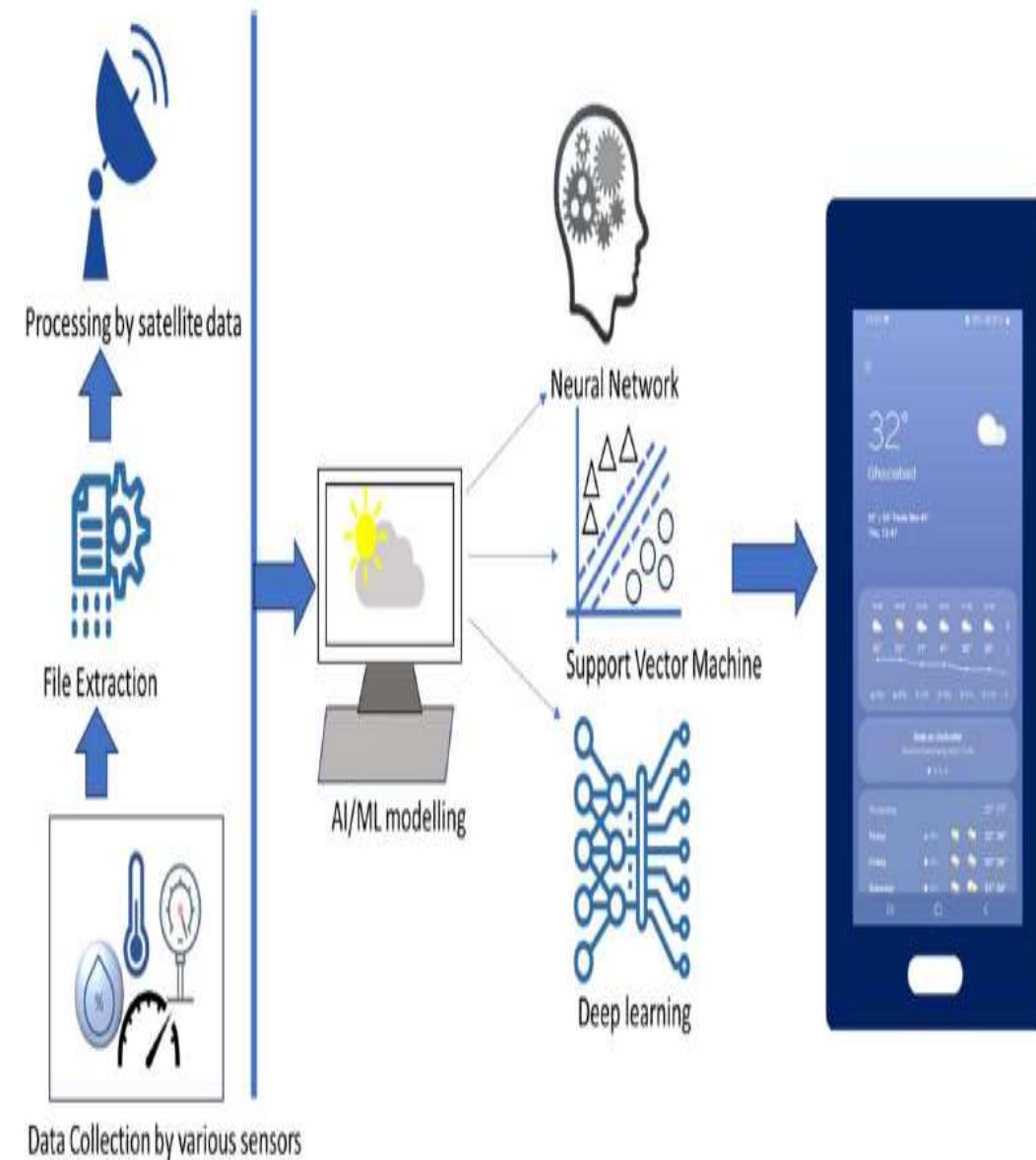
- AI for Water Conservation
- Predicting Water Shortages

AI Tool/Method	Purpose/Use	Example
Machine Learning Algorithms	Pattern detection, prediction, and forecasting	River Aware for water health prediction
Convolutional Neural Networks (CNNs)	Image analysis (satellite, drone)	Detecting deforestation via remote sensing
AI-powered Sensors & IoT	Real-time air/water/soil monitoring	Continuous air pollution detection
Remote Sensing & Image Analysis	Land cover change & disaster detection	Mapping deforestation, tracking wildfires

# Weather Forecasting by AI/ML

Table: Illustration of key sensors used in weather forecasting, their functions, and examples of advanced AI and machine learning tools

Sensor Type	Measures	Working Principle	Example Uses	AI/ML Tools and Role
Temperature Sensor	Air temperature	Measures resistance or voltage changes due to heat	Predict temperature trends	Multiple Linear Regression (MLR) for temperature prediction
Humidity Sensor	Moisture in air	Detects capacitance/resistance changes due to water vapor	Forecast rain, fog, humidity levels	Random Forest, Support Vector Machines (SVM) for humidity prediction
Barometric Pressure Sensor	Atmospheric pressure	Uses piezoelectric/piezoresistive elements	Track pressure systems	Ensemble Learning methods for storm prediction
Precipitation Sensor	Rainfall amount and type	Tipping bucket, optical, radar sensors	Measure rainfall, snow	Deep Learning models for precipitation intensity and timing
Wind Speed Sensor (Anemometer)	Wind speed	Measures rotations or ultrasonic travel time	Storm tracking, wind speed forecasting	Neural Networks for wind pattern recognition
Solar Radiation Sensor	Sunlight intensity	Photosensitive elements detect radiation	Climate studies, solar energy forecasts	Neural Networks and Regression for solar radiation prediction



# SMART AND SUSTAINABLE AGRICULTURE

Feature	Smart Agriculture	Sustainable Agriculture
Primary Focus	Uses modern technology and tools to help farmers grow more food using fewer resources like water, land, and energyEfficiency through technology	It is a way of farming that looks after the environment, conserves resources, and supports farmers to keep growing food for a long time without harming nature
Tools & Techniques	Efficiency through technology e.g., IoT, AI, drones, sensors, data analytics	Organic farming, crop rotation, conservation practices e.g., using drip irrigation to save water
Goal	Maximize productivity and resource optimization	Conserve resources and ensure future food security
Environmental Impact	May reduce inputs but not always eco-friendly	Prioritizes minimal ecological footprint
Social Considerations	Often tech-centric, less focus on labor equity	Emphasizes fair labor and community well-being
Economic Model	High initial investment, tech-driven profitability	Balanced profitability with ecological and social costs
Examples	Precision farming (uses advanced sensors and analysis tools to boost crop yields), automated irrigation	Agroforestry, permaculture (holistic approach to land management), organic certification

# Need for Smart and Sustainable Agriculture

## WHY?

- Rising population and food demand
- Climate change challenges
- Water scarcity
- Soil degradation
- Reducing environmental impact



The soil moisture sensor has two or more probes that are inserted into the soil. These probes detect the electrical resistance or capacitance of the soil, which changes with water content:

- Wet soil conducts electricity well → low resistance
- Dry soil conducts poorly → high resistance

The sensor sends this information to a display unit, mobile app, or automated irrigation system.

Farmers can then irrigate only when the soil is dry, saving water and improving crop yield. Example Devices: Vegetronix VH400, Decagon EC-5

Methodology	Working	Example / Application
Drip Irrigation	Delivers water directly to plant roots, saving water	Drip systems for vegetables, sugarcane, paddy
Soil Moisture Sensors	Measures soil water content to guide irrigation	Vegetronix VH400, Decagon EC-5
DIY Composting	Converts kitchen and farm waste into organic fertiliser	Compost pits or homemade vermicompost bins
Crop Rotation	Alternating crops to maintain soil nutrients and reduce pests	Pulses after cereals, maize + legumes
Mobile Apps for Weather Alerts	Provides real-time weather forecasts and advisories	Kisan Suvidha App, Skymet Weather Alerts
Solar-Powered Pumps	Uses solar energy for irrigation, reducing electricity use	Solar pump for farm irrigation
Mulching with Farm Waste	Covers soil with straw or leaves to retain moisture	Straw mulch in vegetable fields

# Advanced Engineering for Modern Farming



**HYDROPONIC FARMING**

- It is a method where plant roots are kept in direct contact with nutrient-rich water or supported by materials like cocopeat, perlite, or clay pellets.
- This water contains essential nutrients like nitrogen, phosphorus, potassium, calcium, and magnesium.
- O<sub>2</sub> supply is maintained through air pumps
- Farms in Delhi, Bangalore, and Pune are now supplying fresh lettuce, spinach, and herbs directly to restaurants and supermarkets.
- Requires 70% less water than traditional farming.
- Can be done indoors or in cities (urban farming).
- No soil means no weeds or soil-borne diseases. Faster growth and higher yields



**AEROPONIC FARMING**

- Plant roots are suspended in the air and regularly sprayed with a fine mist of nutrient-rich water.
- Plants placed in a closed chamber with roots hanging in the air are sprayed or misted with water mixed with nutrients directly to the roots. Oxygen from the air reaches the roots easily, helping in faster growth.
- NASA has tested it for growing food in space missions, as it requires very little water and soil.
- Some startups in Gurugram and Bangalore are using aeroponics to grow leafy vegetables
- Uses 95% less water compared to soil farming.
- Space-saving by performing vertical farming.
- No soil means no pests and no weeding.



**POLYHOUSE FARMING**

- A polyhouse is a protected farming structure made of a transparent plastic sheet
- Sheet is supported by a metal or bamboo frame.
- Acts as a greenhouse but is smaller and more affordable for farmers.
- In polyhouse, the temp., humidity, and light can be controlled, plants grow faster and healthier.
- Farmers in Haryana and Maharashtra grow capsicum and cucumber earning higher incomes

# GREEN COMPUTING

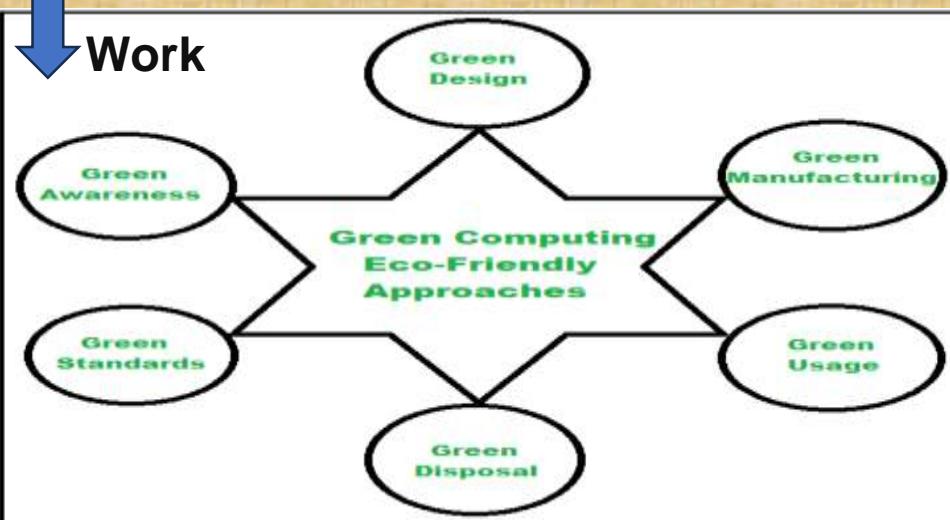
## Key aspects

**Energy Efficiency:** Reducing power consumption in data centers and personal computing devices.

**Eco-friendly Manufacturing:** Sourcing raw materials and manufacturing processes that lower carbon footprints.

**Responsible Disposal:** Properly recycling e-waste to prevent harmful substances from polluting the environment.

## Approaches of Green Computing



➤ “Green computing is the practice of implementing eco-friendly tactics into the use of computers and their daily functions need to be correlated with the environmental actions necessary for the sustainability.” The term Green computing came into existence with the launch of Energy Star program in 1992 by U.S environmental protection agency.

➤ Green computing is also commonly referred to as sustainable computing or green information technology or Green IT.

**Cloud Computing:** Cloud computing means storing and accessing data and programs over the internet instead of your own computer’s hard drive. Examples: Google Drive, Microsoft OneDrive, Zoom, Netflix. It Supports Green Computing by

➤ One cloud server can serve hundreds of users, reducing the need for many personal computers running constantly.

➤ Store files digitally instead of printing that saves paper & trees. Online assignments & cloud-based exams to reduce paper use.

➤ No need to travel for meetings or classes that will reduce fuel consumption. E.g. Online classes via Zoom or Google Meet

➤ Cloud providers use energy-efficient servers that reduces carbon footprint. Microsoft Azure and Amazon AWS run green data centers.

# KEY POINTS

