AI’s Environmental Impact & Mitigation

For Prelims: UNEP, Artificial Intelligence (AI), LLM (large language model), Rare Earth Elements, E-waste, Greenhouse Gas (GHGs), Recommendation on the Ethics of Artificial Intelligence, UNESCO, Carbon Credits.

For Mains: Environmental impact of artificial intelligence (AI) life cycle and ways to mitigate them.

Source: TH

Why in News?

Amid rising global adoption of **artificial intelligence (AI)**, many experts have raised concerns about the **environmental impacts of the AI life cycle** and recommended **measures to mitigate** them.

What is Artificial Intelligence (AI)?

- **About: AI** refers to the **simulation of human intelligence** in machines, enabling them to perform tasks that typically require **human cognition**, such as **learning, reasoning, problem-solving, perception, and decision-making**.
- **AI Market:** The global AI market is valued at **USD 200 billion** and could contribute **USD 15.7 trillion** to the economy by **2030.**
- **India’s Initiatives:** India plans to build its own **LLM (large language model)** to compete with **DeepSeek** and **ChatGPT**.
    - India launched “**AI for India 2030 initiative**” that emphasizes **ethical, inclusive and responsible AI adoption** to position India as a global leader in AI innovation.
- **AI Life Cycle:** It refers to the structured process of **developing, deploying, and maintaining AI models** to deliver meaningful results.

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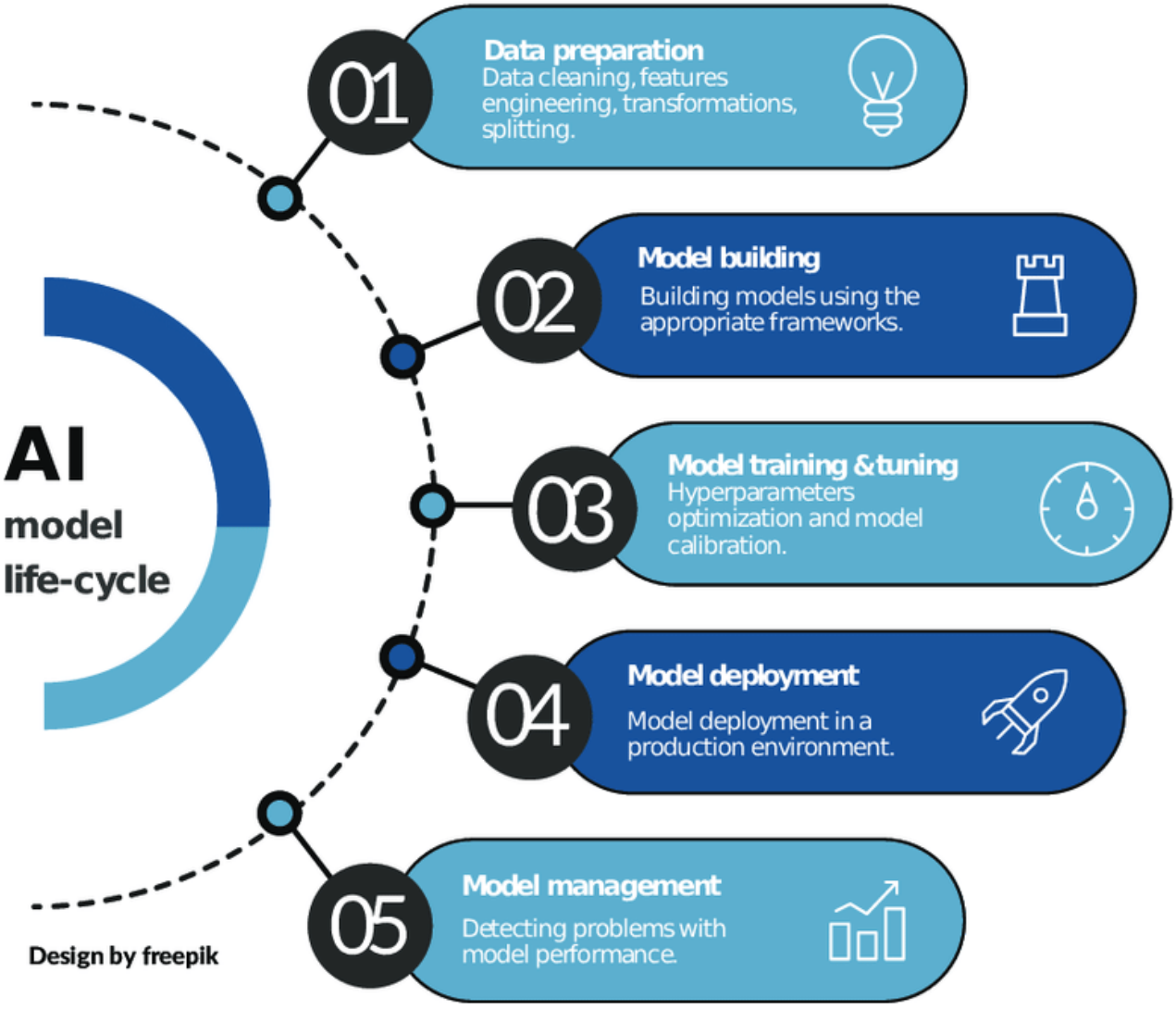

AI Data Centers

- **About:** AI data center is a **specialized facility** that provides the **computing power, storage, and networking** needed for AI model processing and training.
- **Key Features:**
  - **High-Performance Computing (HPC):** Uses GPUs, and accelerators for **fast model training** and complex computations.
  - **Massive Storage:** Stores **large training data** and AI outputs e.g., cloud storage.
  - **Efficient Networking:** High-speed **interconnection** ensures real-time data transfer.
  - **Energy Efficiency:** Uses **liquid/air cooling** and renewable energy to manage high power consumption.

What are the Environmental Impacts of AI?

- **GHG Emissions:** AI-driven data centres require vast amounts of **electricity**, mostly sourced from **fossil fuels**.
  - AI hardware and data centres currently contribute **1% of global** **Greenhouse Gas**

(GHGs) emissions, and this is **expected to double by 2026.**
    - E.g., Training one LLM emits **3,00,000 kg of CO_2**, (equivalent to **five cars' lifetime emissions**).
- **Increased Computing Power:** Generative AI models like **ChatGPT** use **10–100 times more power** than earlier versions, increasing demand for **graphic processing units (GPUs)** and worsening the **environmental footprint.**
    - E.g., a single LLM query requires **2.9 watt-hours** of electricity, compared with **0.3 watt-hours for a regular internet search.**
- **E-waste Generation:** Data centers generate substantial **e-waste**, including hazardous substances like **mercury** and **lead,** exacerbating the **global e-waste crisis.**
    - Generative AI could account for up to **5 million metric tons of e-waste by 2030.**
- **Impact of Other Inputs Related to AI Industry:** AI data centers require vast raw materials, with AI chips depending on **REEs** from harmful mining.
    - They also consume significant water for **cooling of data centers**.

What Initiatives are Taken to Curb the Environmental Impacts of AI?

- **COP29 of UNFCCC:** At COP29 of **UNFCCC** 2024 in Baku, Azerbaijan, the **International Telecommunication Union** emphasised the urgent need for **greener AI practices.**
- **Legislative Actions:** Both the **EU (EU AI Act, 2024)** and the **US (Artificial Intelligence Environmental Impacts Act, 2024)** have enacted laws to **reduce AI's carbon footprint** and promote sustainable practices.
- **Global Ethical Guidelines:** Over **190 countries** adopted **non-binding ethical AI guidelines** at **UNESCO's "Recommendation on the Ethics of Artificial Intelligence"** promoting sustainability b**y reducing carbon footprint, and energy consumption.**
- **AI Action Summit 2025:** UN Secretary-General urged countries to **design AI algorithms and infrastructures** that **consume less energy** and integrate AI into **smart grids** to optimize power use.
- **UNEP's Recommendations: UNEP** has proposed **five key strategies** to mitigate AI's environmental footprint:

Way Forward

- **Renewable Energy:** Companies should use **renewable energy** for data centers and locate them in **renewable energy-rich regions** to reduce fossil fuel emissions.
    - **Purchasing carbon credits** can help offset emissions.
    - AI itself can help **enhance the efficiency** of **renewable energy grids** for a smoother clean energy transition. E.g., Use of **Google's DeepMind** to improve **wind energy forecasting.**
- **Energy-Efficient Models: Smaller, domain-specific** AI models, optimised algorithms, specialised hardware, and **energy-efficient** cloud data centres can reduce the carbon footprint by **100 to 1,000 times.**

- Businesses should use **pre-trained AI models** instead of training from scratch to save energy and computation.
- **Transparency and Accountability:** Organizations need **standardized frameworks** for tracking AI emissions and clear **sustainability reporting** to ensure accountability and reduce environmental impact.

Drishti Mains Question:

Discuss the environmental costs associated with the artificial intelligence (AI) life cycle. How can sustainable AI practices mitigate these impacts?

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. With the present state of development, Artificial Intelligence can effectively do which of the following?(2020)

1. Bring down electricity consumption in industrial units
2. Create meaningful short stories and songs
3. Disease diagnosis
4. Text-to-Speech Conversion
5. Wireless transmission of electrical energy

Select the correct answer using the code given below:

(a) 1, 2, 3 and 5 only

(b) 1, 3 and 4 only

(c) 2, 4 and 5 only

(d) 1, 2, 3, 4 and 5

Ans: (b)

Mains

Q. What are the main socio-economic implications arising out of the development of IT industries in major cities of India? (2021)

Q. “The emergence of the Fourth Industrial Revolution (Digital Revolution) has initiated e-Governance as an integral part of government”. Discuss. (2020)