The Environmental Impact of Building AI Systems: Balancing Technological Advancement with Sustainable Practices

Understanding the Ecological Costs and Benefits of AI

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Date: Monday, October 14, 2024

WLDA/KPMG Tech Talk

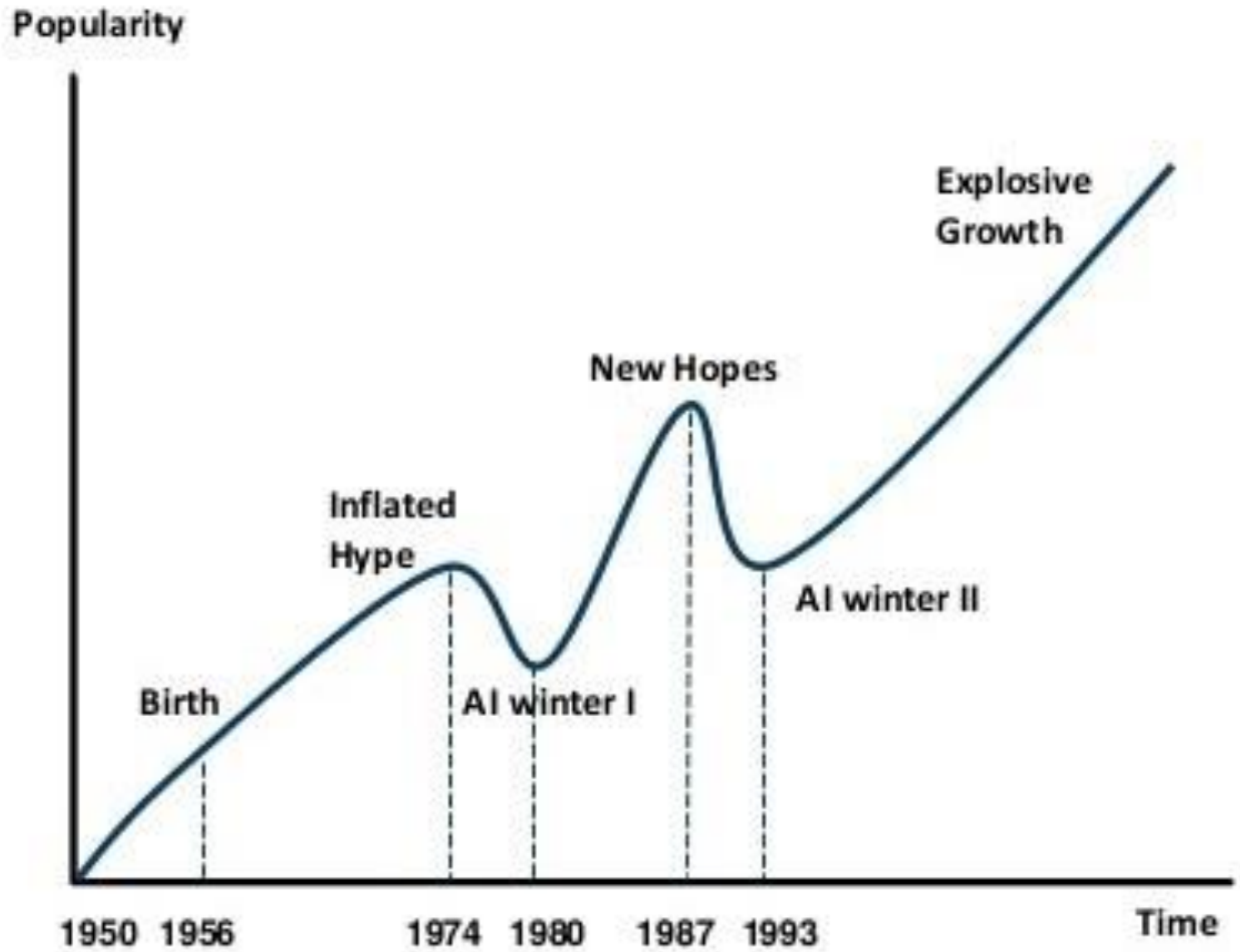
Objectives

- Understand both the environmental benefits and risks of AI.
- Recognize the need for strong regulations to reduce AI's environmental impact.
- Role and importance of transparency in AI’s resource use.
- Learn how integrating ESG factors can align AI with sustainability.
- How to promote sustainable practices in AI development for a positive environmental impact.

Overview

- Rapid growth of technological advancements of AI.
- Significant environmental impacts associated with AI development and deployment.
- Balancing Technology and sustainability.

AI HAS A LONG HISTORY OF BEING "THE NEXT BIG THING"...



Timeline of AI Development

- **1950s-1960s**: First AI boom - the age of reasoning, prototype AI developed
- **1970s**: AI winter I
- **1980s-1990s**: Second AI boom: the age of Knowledge representation (appearance of expert systems capable of reproducing human decision-making)
- **1990s**: AI winter II
- **1997**: Deep Blue beats Gary Kasparov
- **2006**: University of Toronto develops Deep Learning
- **2011**: IBM's Watson won Jeopardy
- **2016**: Go software based on Deep Learning beats world's champions

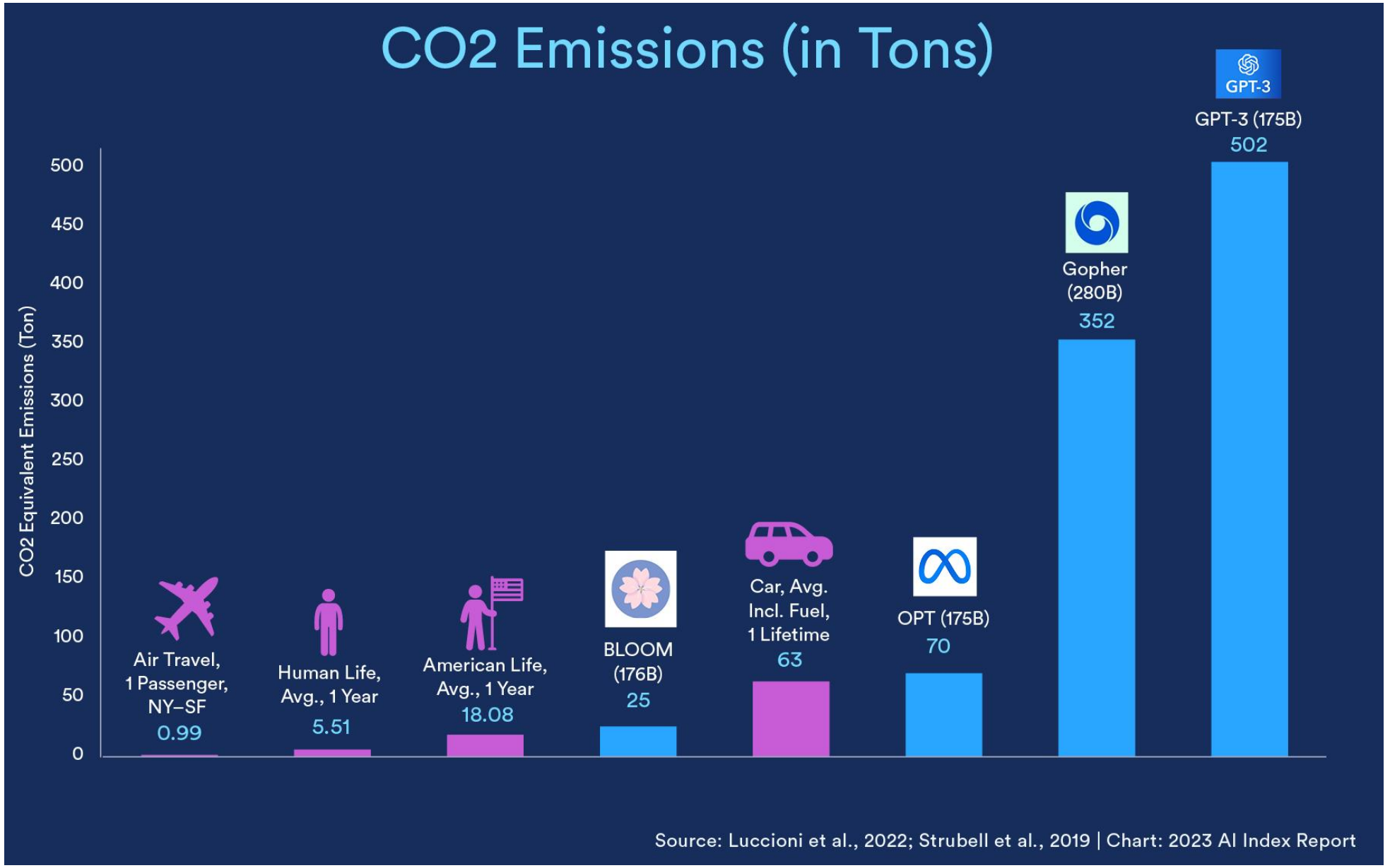
AI's Environmental Impact

- Energy Consumption: Data centers globally use 1-1.5% of electricity
- Future Energy Demand: 85.4 terawatt-hours annually
- Cooling and Infrastructure: Cooling adds 10-50% to the energy costs of AI servers
- AI Enabled Search Engines: Energy consumption could rival Ireland's energy usage.

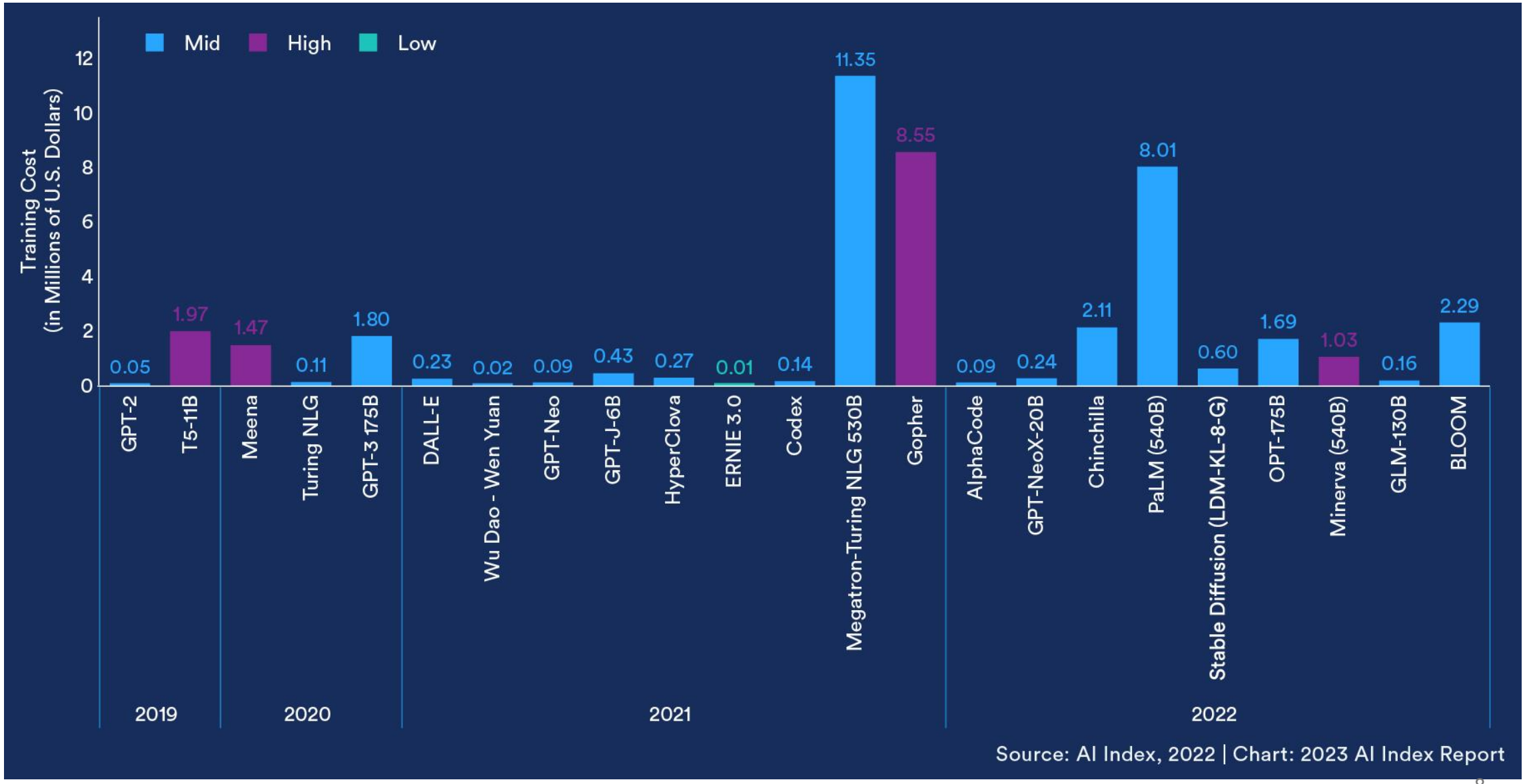
AI’s Environmental Impact

- **AI Development:** AI's training and inference phases are both energy-intensive *[models like ChatGPT requiring significant power during inference]*.
- **Efficiency vs. Demand:** Increased efficiency often leads to greater demand, which negates energy savings.
- **Need for Transparency:**
  - More data on energy sources (renewable vs. fossil fuels) and AI server locations is required.
  - Regulatory oversight needed to ensure transparency in AI’s energy use.

High Environmental Costs of Training

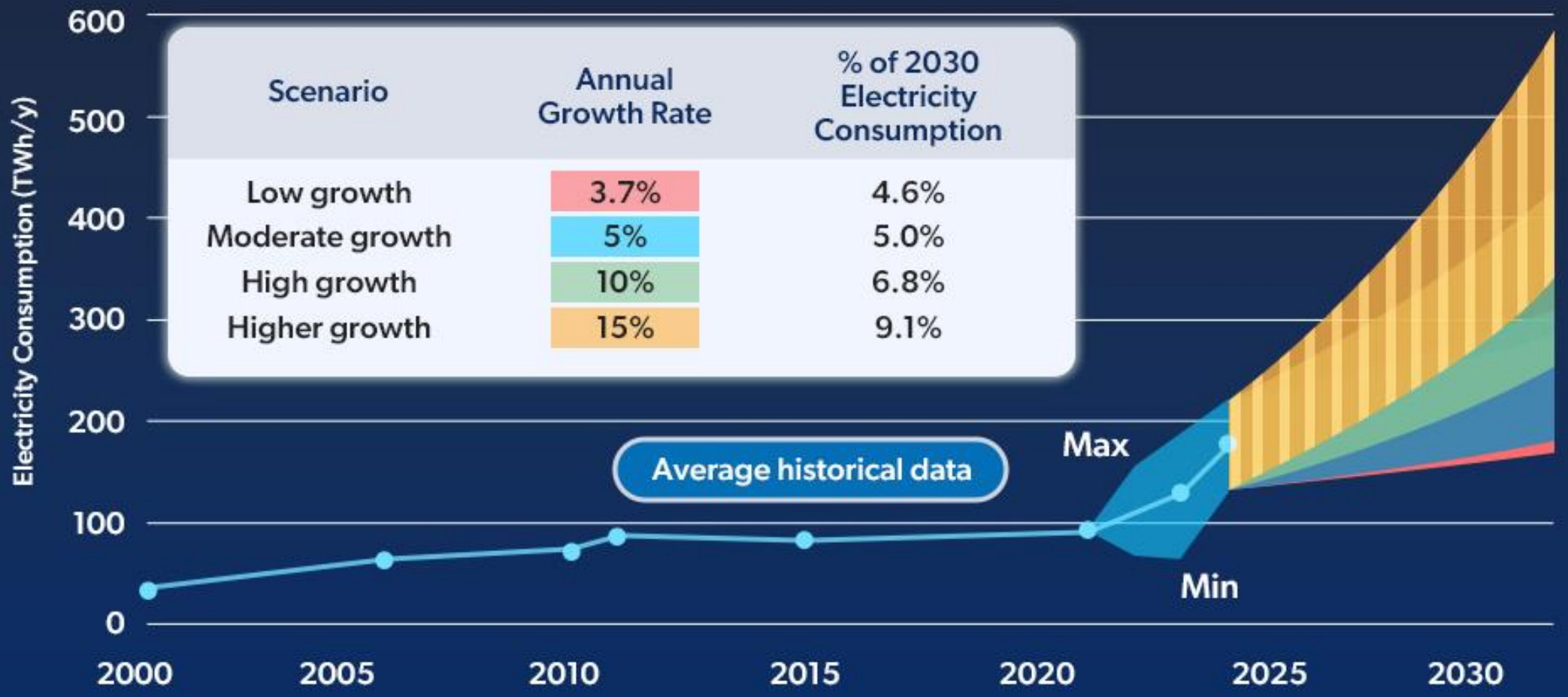


Estimated Training Costs of Large Models



https://hai.stanford.edu/news/2023-state-ai-14-charts

Projections of potential electricity consumption by U.S. data centers 2023 – 2030



% of 2030 electric consumption projections assume that all other (non-data center) load increases at 1% annually.

Source: Electric Power Research Institute (EPRI) 2024

Case Study: Generative AI and Resource Use

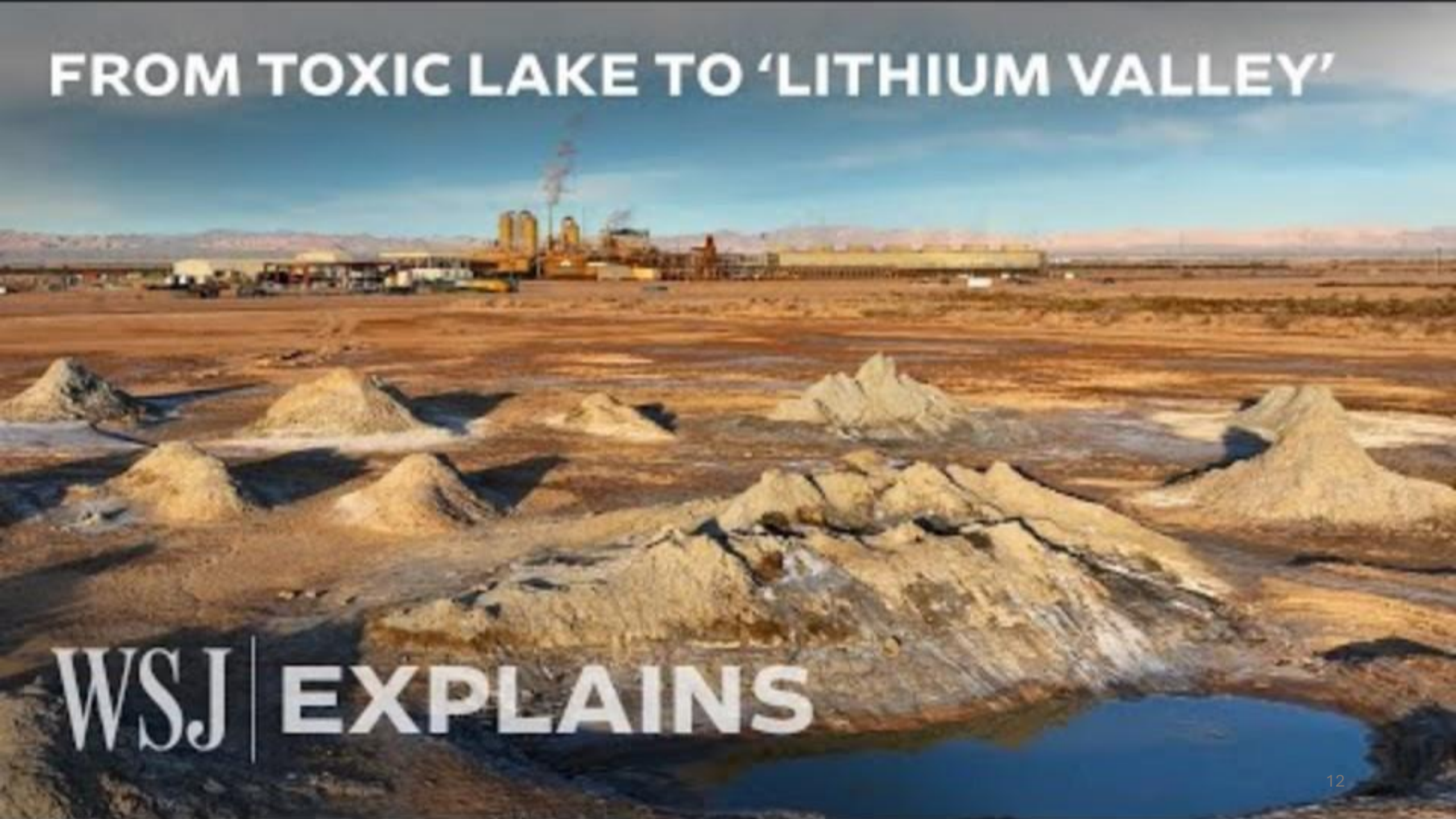
Impact on Natural Resources:

- Substantial use of minerals and water in data center operations and hardware production (Warso & Shrishak, 2024).
- AI data centers' energy and water demands for cooling, particularly in water-scarce regions has exacerbated water access issues for communities.

QTS data center under construction in Litchfield Park, Arizona. ASH PONDERS / BLOOMBERG VIA GETTY IMAGES.
Source: https://e360.yale.edu/features/artificial-intelligence-climate-energy-emissions

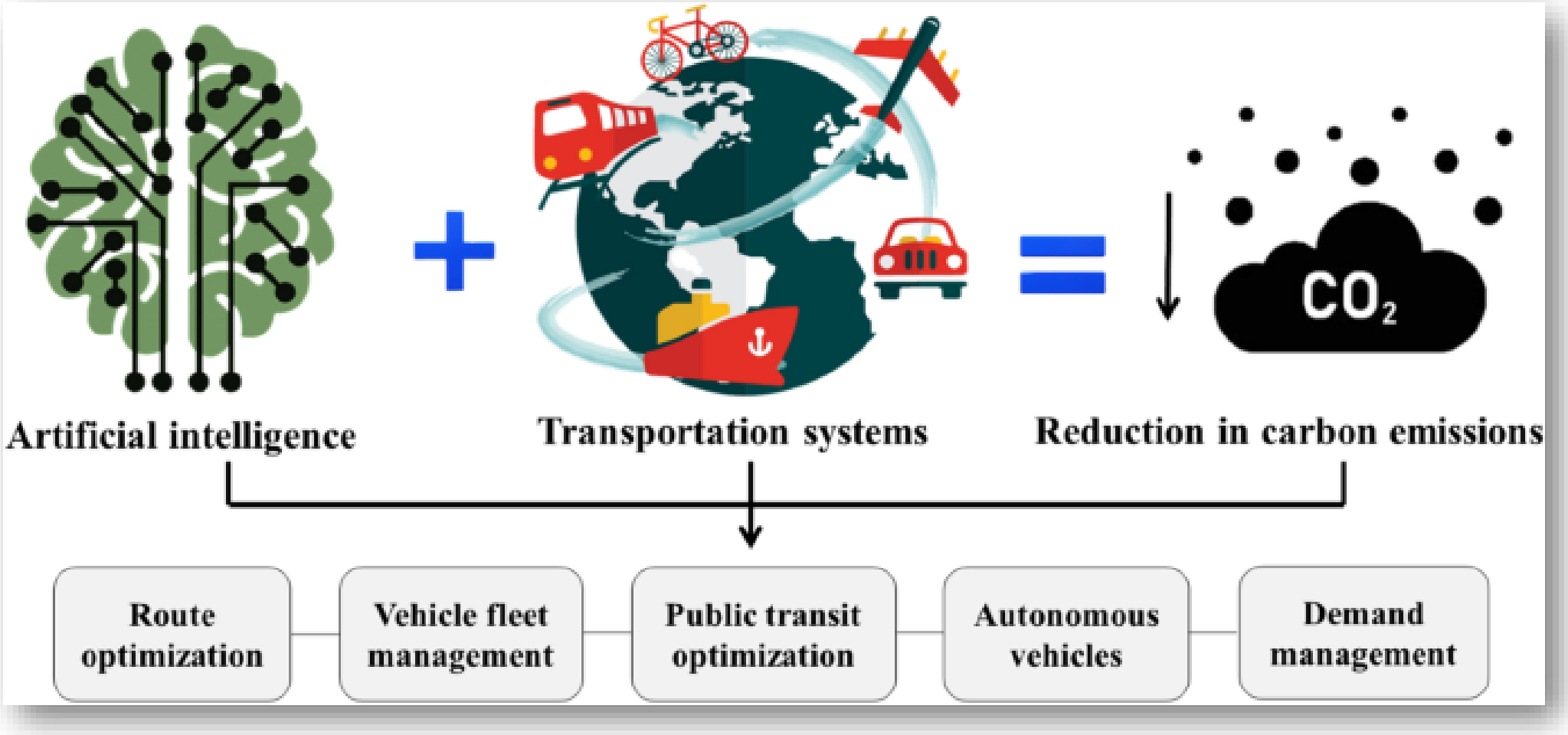
Case Study: Generative AI and Resource Use

- Mineral Extraction of Rare Earth Elements (REEs): due to their unique properties, such as strong magnetism, fluorescence, and conductivity.
  - Minerals; Lithium, Cobalt, and Rare Earth Elements/RREs like Neodymium, Dysprosium, Gadolinium, Lanthanum, Yttrium, Terbium, Cerium, Erbium, and Europium are essential in various computer components, from hard drives and processors to display screens and communication systems.
- Computer and Technology relies on REEs: often sourced from environmentally sensitive locations, and utilizing damaging mining activities.

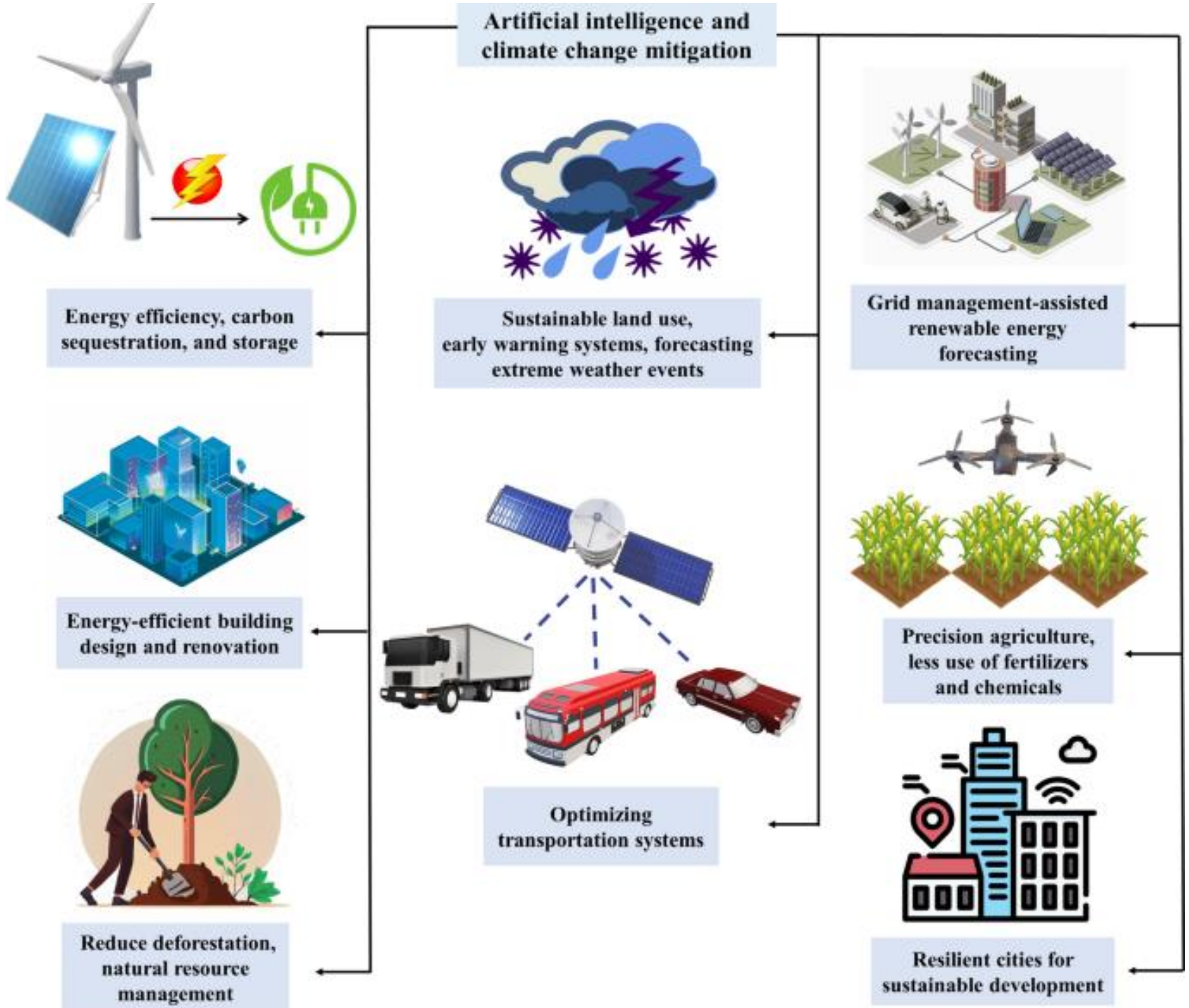

FROM TOXIC LAKE TO 'LITHIUM VALLEY'
WSJ | EXPLAINS

Can AI Solve Climate Change?

Artificial intelligence-based solutions for climate change



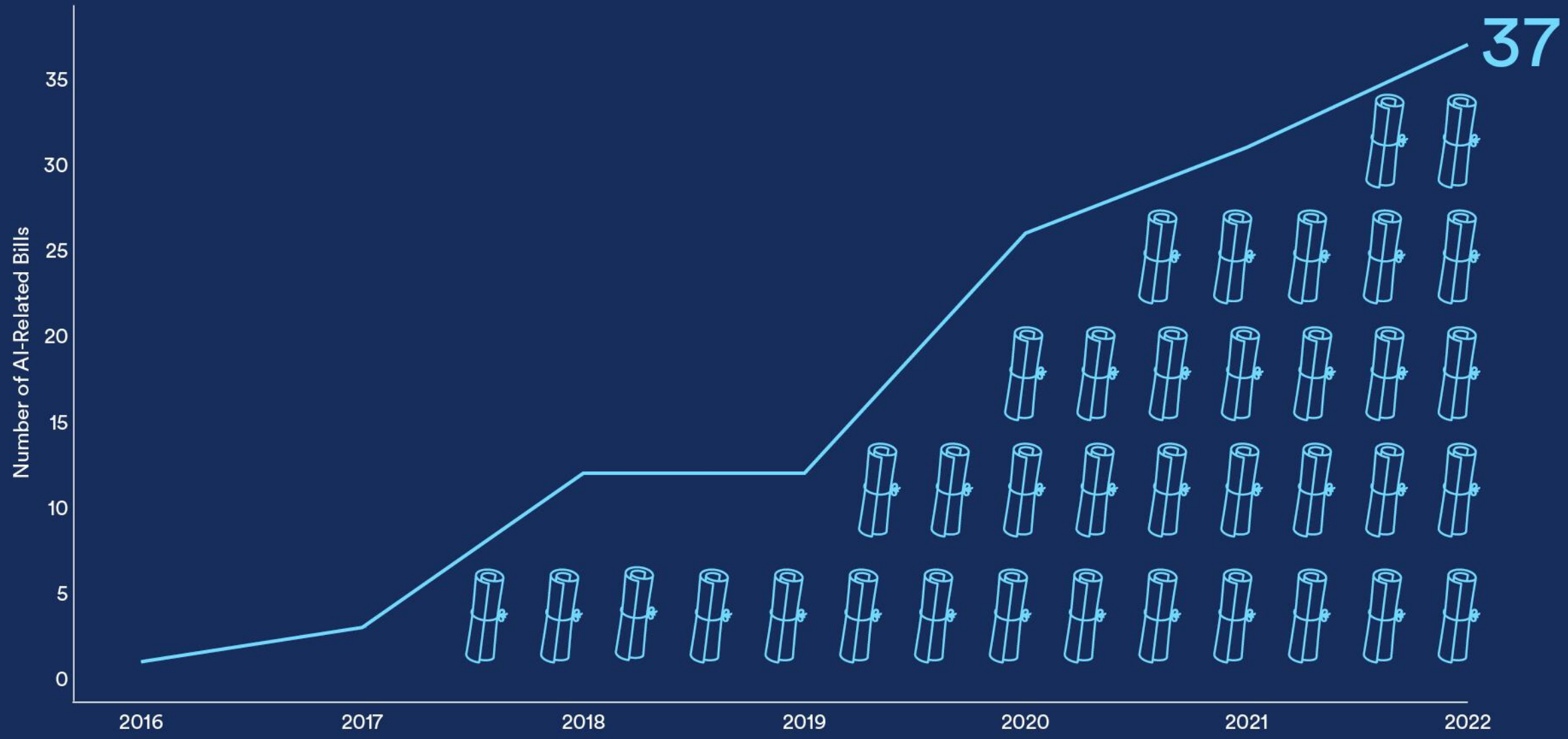
Chen, L., Chen, Z., Zhang, Y. et al. Artificial intelligence-based solutions for climate change: a review. Environ Chem Lett **21**, 2525–2557 (2023). https://doi.org/10.1007/s10311-023-01617-y


Artificial intelligence and climate change mitigation
Energy efficiency, carbon sequestration, and storage
Sustainable land use, early warning systems, forecasting extreme weather events
Grid management-assisted renewable energy forecasting
Energy-efficient building design and renovation
Precision agriculture, less use of fertilizers and chemicals
Optimizing transportation systems
Reduce deforestation, natural resource management
Resilient cities for sustainable development

AI Regulation and Legislation

Governing Environmental Impacts of AI Development

Number of AI-Related Bills Passed into Law Globally



Source: AI Index, 2022 | Chart: 2023 AI Index Report

Legislative Responses to AI's Environmental Impact

European Union's AI Act:

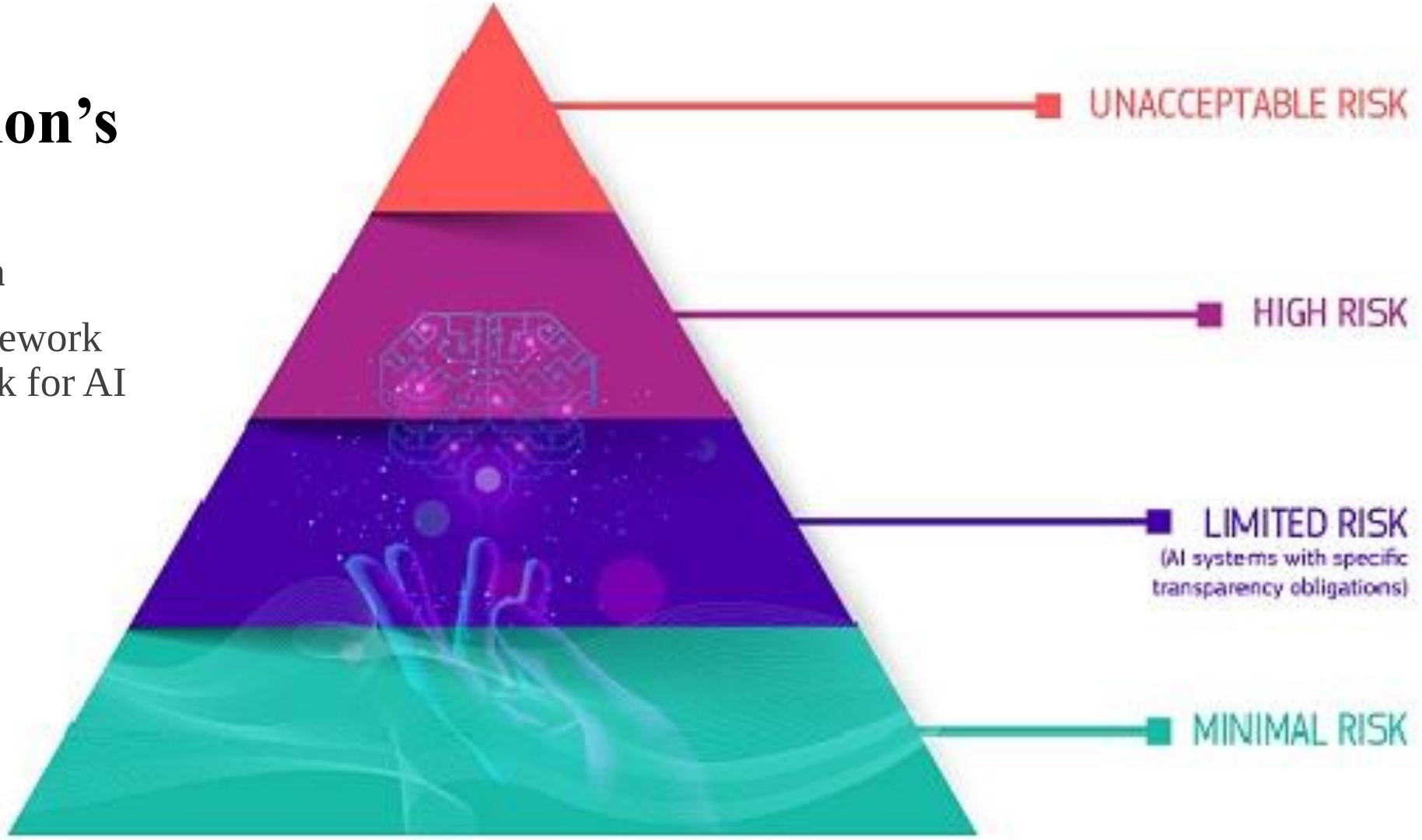
- Focus on “AI for sustainability” and address associated challenges and gaps (Warso & Shrishak, 2024).
- Outlines a Risk Based Framework
  - Both for algorithmic risks (i.e., Bias) and
  - Environmental Risks and Impacts

Legislative Responses to AI's Environmental Impact

European Union's 2024 AI Act:

A risk-based approach

- The Regulatory Framework defines 4 levels of risk for AI systems:



Source: https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai and https://artificialintelligenceact.eu/

Legislative Responses to AI's Environmental Impact

Environmental Impacts Act of 2024:

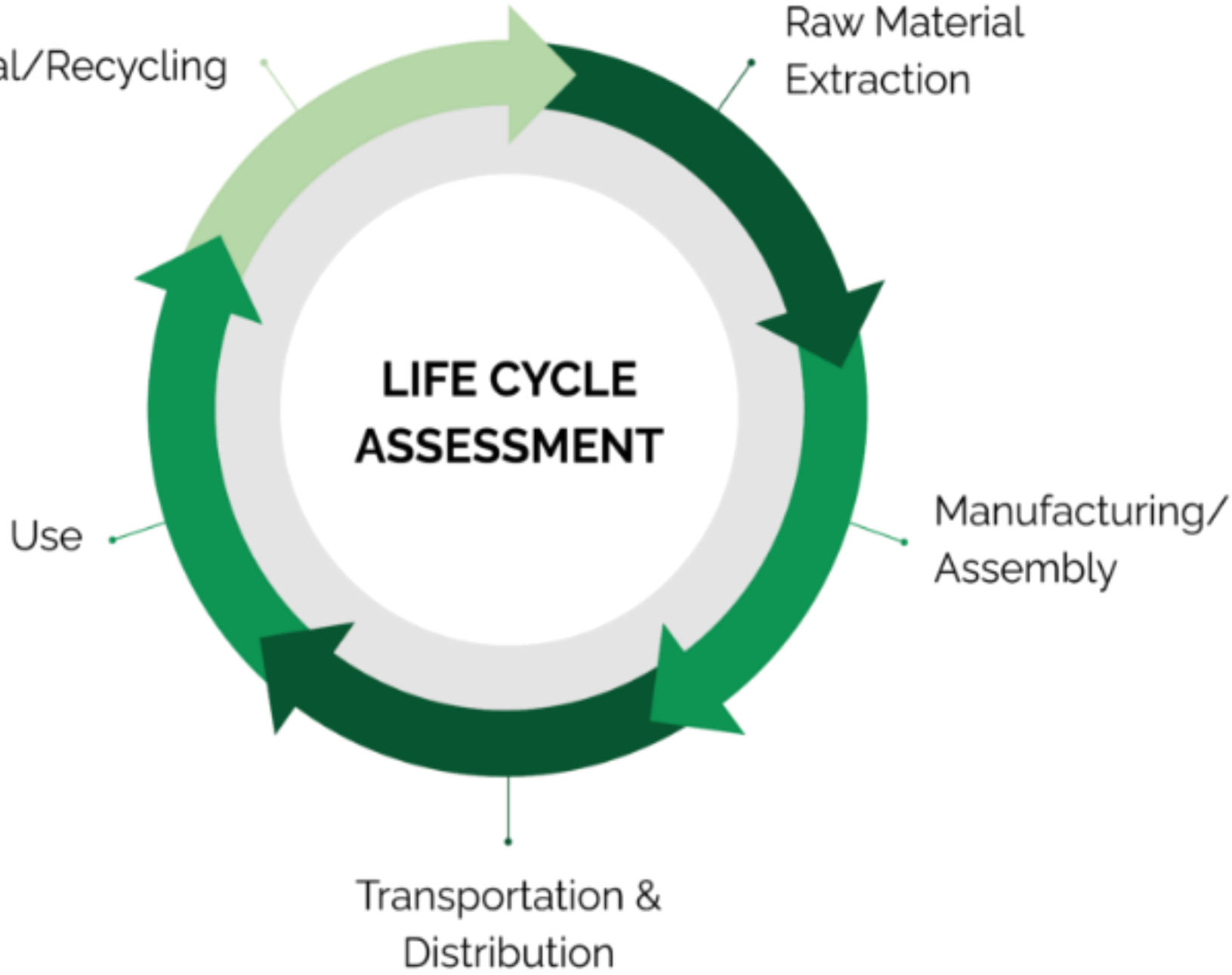
- Study and mitigate AI's environmental impact (Warso & Shrishak, 2024).
- Promote transparency and sustainable practices in AI development

SEC. 5. ARTIFICIAL INTELLIGENCE ENVIRONMENTAL IMPACTS CONSORTIUM.

SEC. 6. REPORTING SYSTEM FOR VOLUNTARY REPORTING OF ENVIRONMENTAL IMPACTS OF ARTIFICIAL INTELLIGENCE.

https://www.congress.gov/bill/118th-congress/senate-bill/3732/text

Approaches and Models to Mitigate Environmental Stress of AI Development



Approaches and Models to Mitigate Environmental Stress

- Environmental, Social, and Governance (ESG) factors are criteria used to evaluate the sustainability and societal impact of investments in AI development.

Takeaways

AI systems present significant **environmental challenges**, including high energy consumption and resource depletion.

AI is also a **tool for environmental management**, offering solutions like energy optimization and climate predictions.

Transparency must be enhanced to properly assess the ecological footprint of AI, as current reporting is insufficient.

Life Cycle Assessment (LCA) methodologies should be adopted to evaluate the full environmental impact of AI from production to usage.

Integrating ESG factors is critical to align AI development with sustainability goals and ensure responsible technological progress.

Balancing AI Advancement with Sustainability

- Championing efforts to improve transparency and accountability in the Tech and AI industry.
- Balanced approach includes robust regulations, sustainable practices, and comprehensive risk assessments.


Questions?

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