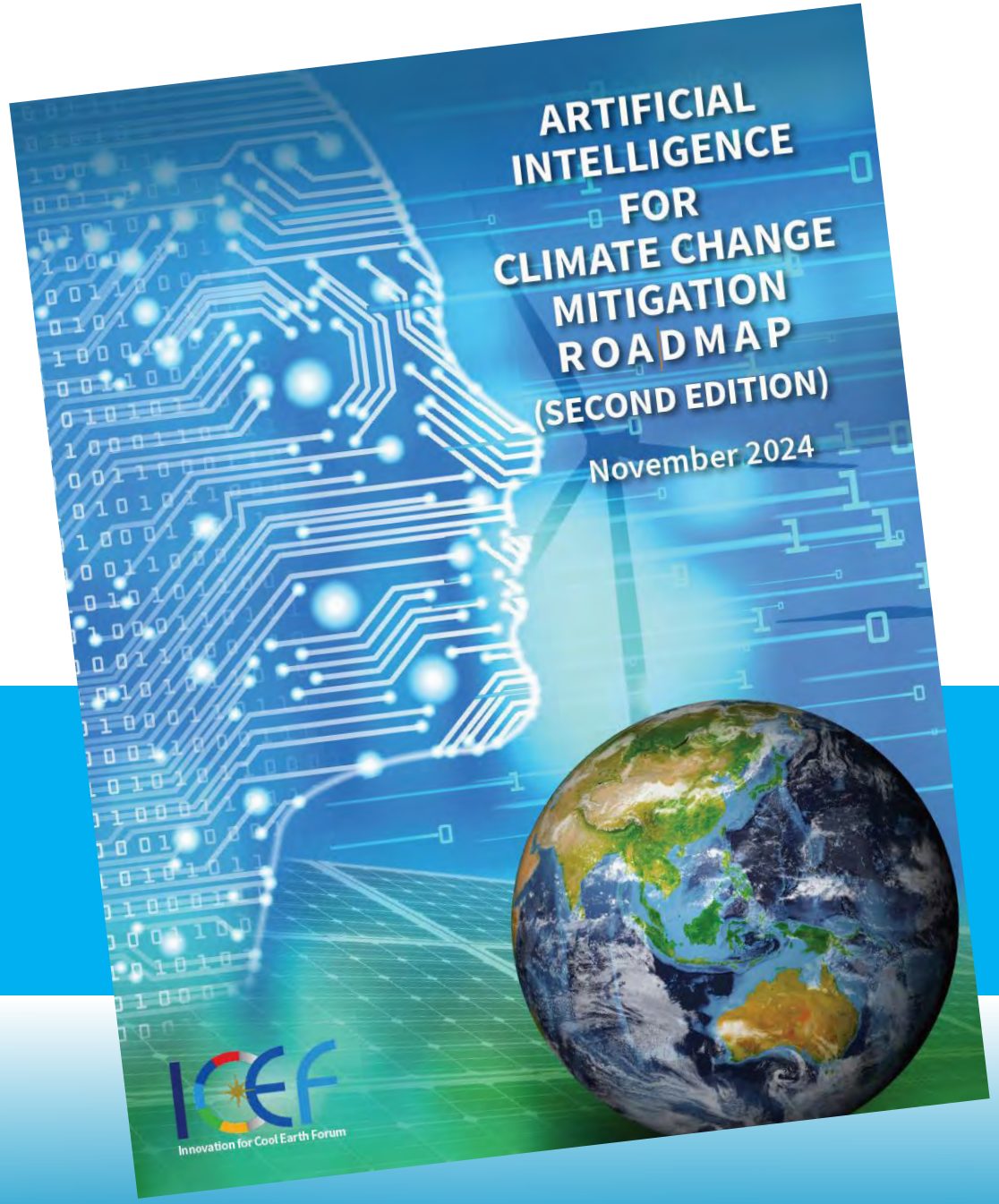

Innovation for Cool Earth Forum

David Sandalow, Colin McCormick, Alp Kucukelbir, Julio Friedmann, Michal Nachmany, Hoesung Lee, Alice Hill, Daniel Loehr, Antoine Halff, Ruben Glatt, Matthew Wald, Philippe Benoit, Kevin Karl and others

NY Energy Forum
April 3, 2025

AI FOR CLIMATE CHANGE MITIGATION ROADMAP (Second Edition) (November 2024)

- ***Topic: How can AI help reduce emissions of greenhouse gases?***

- *17 chapters; 5-10 recommendations in each chapter*

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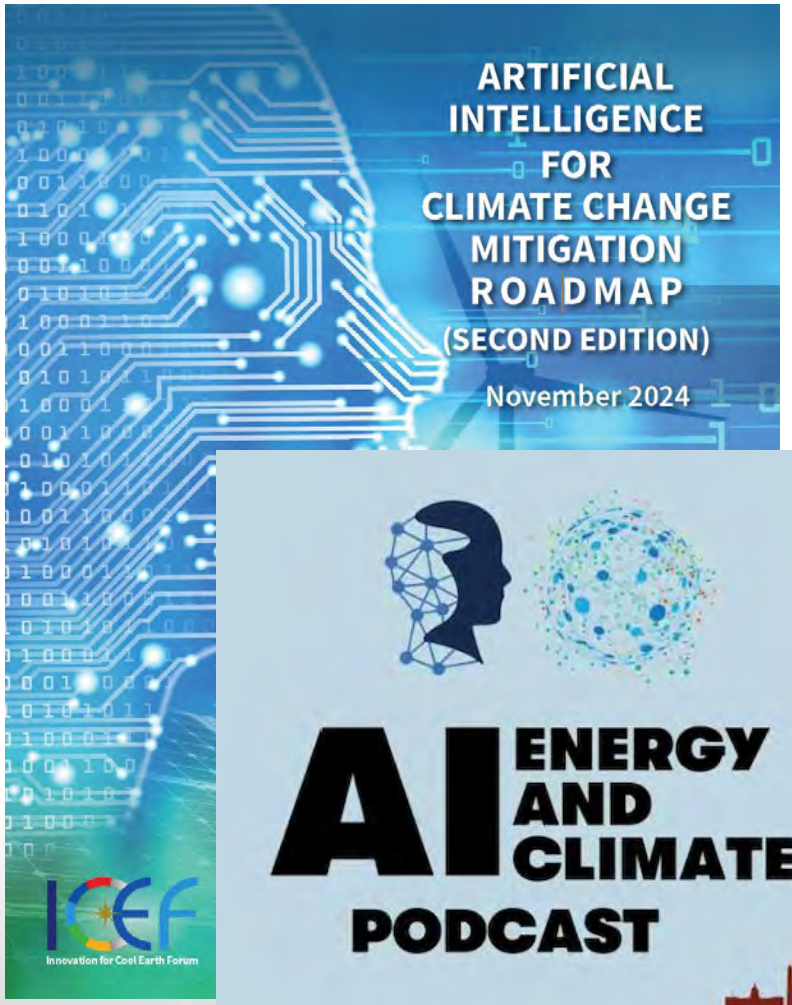


AI FOR CLIMATE CHANGE MITIGATION ROADMAP 2.0 (November 2024)

PART I: **BACKGROUND**

Chapter 1. INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Chapter 2. INTRODUCTION TO CLIMATE CHANGE

PART II: **SECTORS**

Chapter 3. POWER GRID

Chapter 4. FOOD SYSTEM

Chapter 5. MANUFACTURING

Chapter 6. ROAD TRANSPORT

Chapter 7. AVIATION

Chapter 8. BUILDINGS

Chapter 9: CARBON CAPTURE

Chapter 10: NUCLEAR POWER

PART III: **CROSS-CUTTING TOPICS**

Chapter 11. LARGE LANGUAGE MODELS

Chapter 12. GHG EMISSIONS MONITORING

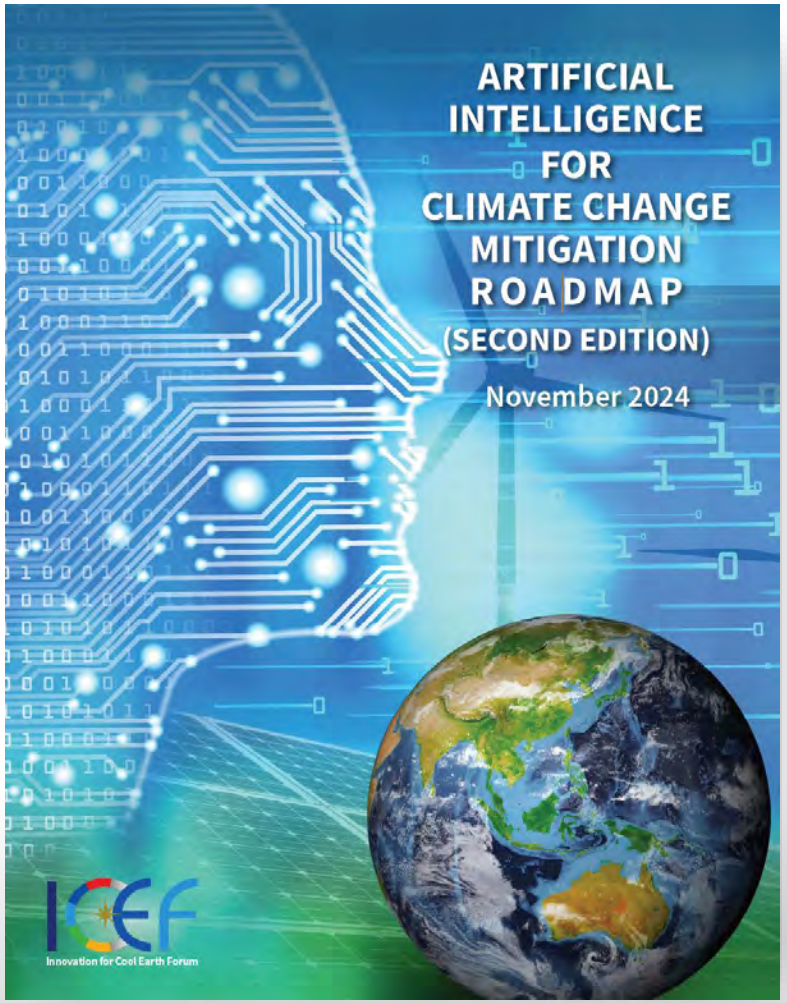
Chapter 13. MATERIALS INNOVATION

Chapter 14. EXTREME WEATHER RESPONSE

Chapter 15: GREENHOUSE GAS EMISSIONS FROM AI

Chapter 16: GOVERNMENT POLICY

Chapter 17: FINDINGS AND RECOMMENDATIONS



Five Key Takeaways

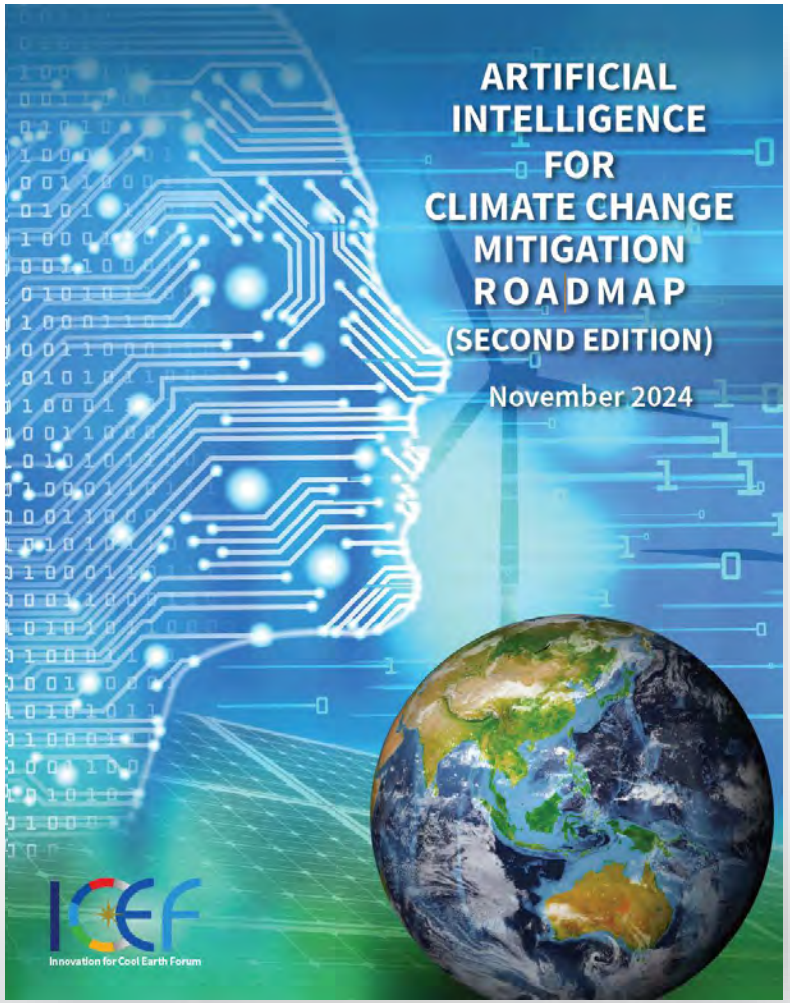
1. AI has the potential to make **significant contributions** to climate change mitigation in the years ahead.

    --**incremental gains** (such as increasing output at solar farms)

    --**transformational gains** (such as helping discover important new materials for clean energy technologies)

2. GHG emissions from computing operations for AI are **less than 1% (and perhaps much less than 1%) of global emissions**, but will very likely rise in the near future.

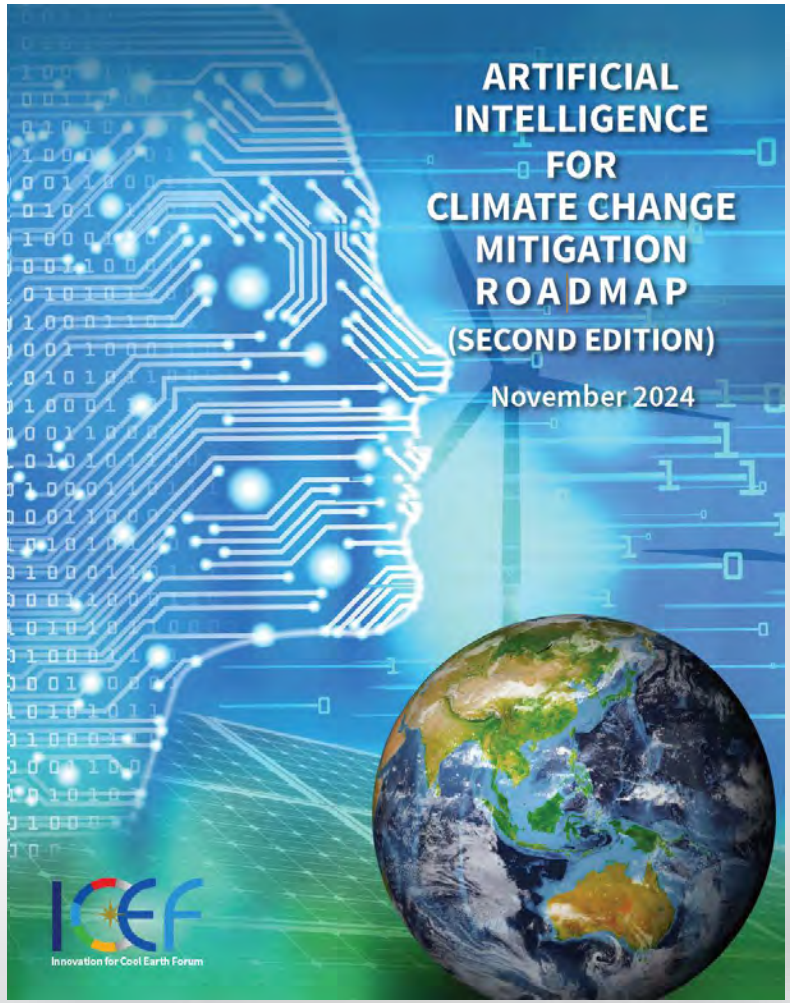
3. The **main barriers** to realizing AI's potential to help reduce GHG emissions are **lack of data** and **lack of trained personnel**.



Five Key Takeaways (cont.)

4. **Trust in AI systems is essential** for AI to deliver substantial benefits for climate change mitigation. For AI to be trustworthy and trusted, risks related to bias, privacy, misinformation, disinformation, safety, security and other issues must be addressed.

5. **Every organization** with a role in climate change mitigation should consider opportunities for AI to contribute to its work.



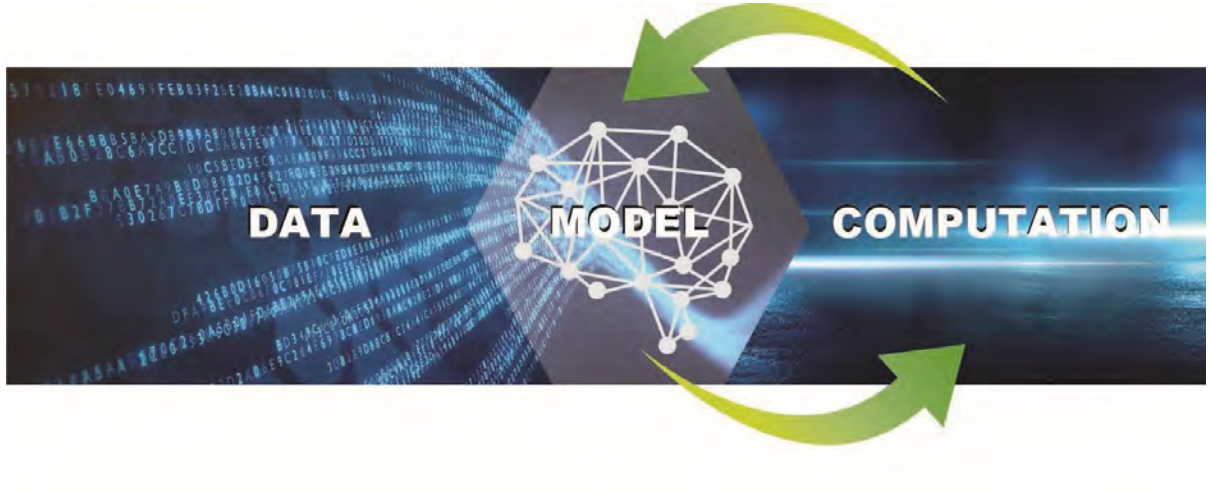
Part I: BACKGROUND

Chapter 1: INTRODUCTION TO AI

- Artificial intelligence (AI) is the science of making computers perform complex tasks

- AI differs from traditional software
  - Instead of relying on explicit programming, AI relies on historical data and simulation to train models and learn patterns

- Modern AI has far-reaching capabilities:
  - Detect -- such as facial recognition
  - Predict – such as ChatGPT
  - Optimize – such as Google Maps routing
  - Simulate -- such as video games

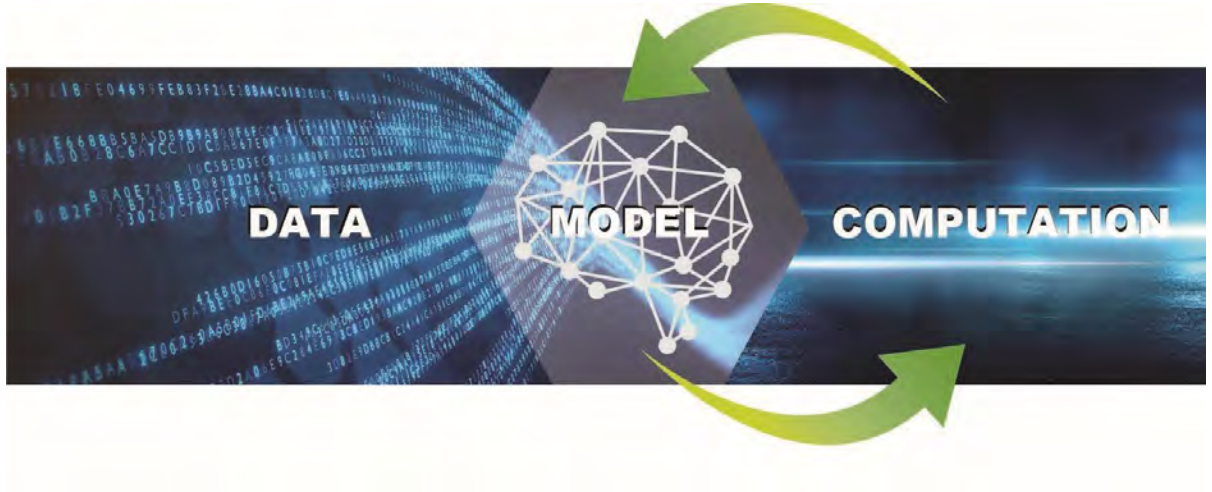


Chapter 1: INTRODUCTION TO AI

- Artificial intelligence (AI) is the science of making computers perform complex tasks

- AI differs from traditional software
  - Instead of relying on explicit programming, AI relies on historical data and simulation to train models and learn patterns

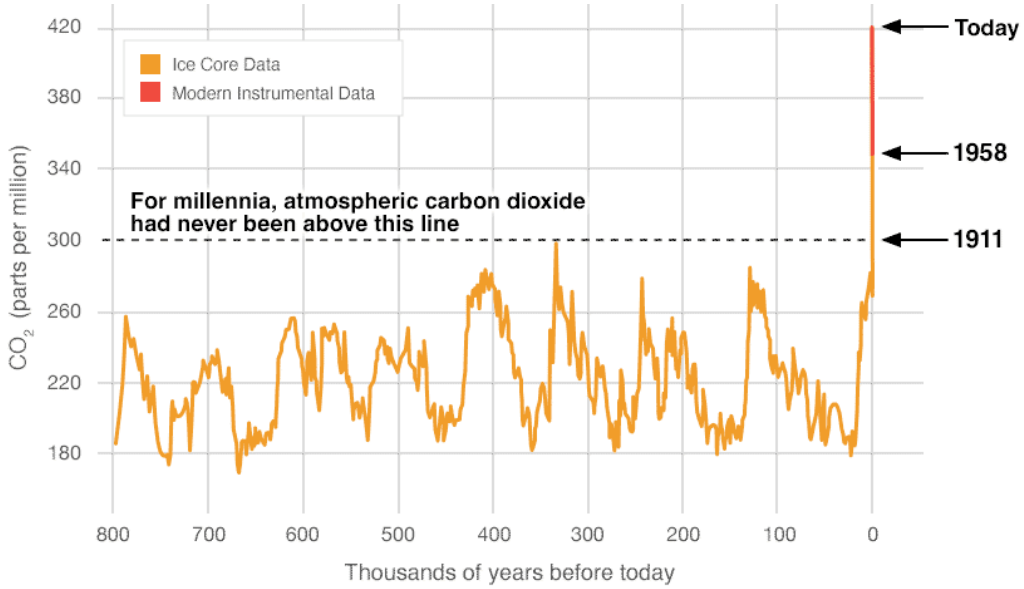
- Modern AI has far-reaching capabilities:
  - Detect – *such as methane emissions from satellite data*
  - Predict – *such as weather patterns at solar/wind farms*
  - Optimize – *such as power flows on transmission lines*
  - Simulate – *such as battery chemistry reactions*



Chapter 2: INTRODUCTION TO CLIMATE CHANGE

- Atmospheric concentrations of heat-trapping gases are now higher than any time in human history.

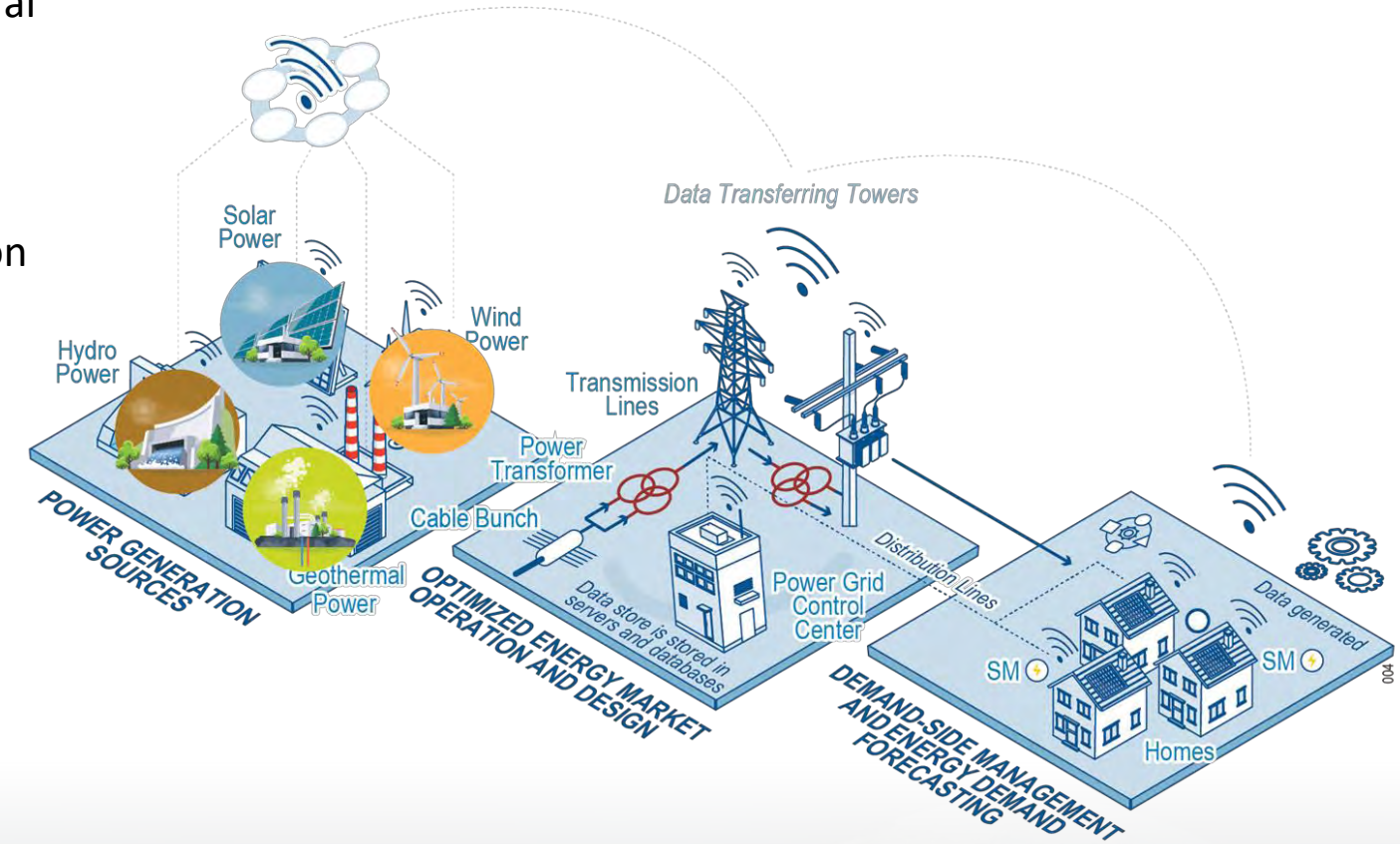
- In terms of global average temperatures:
  - July 22, 2024 was the warmest day ever recorded.
  - 2024 was the warmest year ever recorded, by far.
  - The warmest 11 years ever recorded were the last 11 years.



Part II:
SECTORS

Chapter 3: POWER SECTOR

- Roughly 28% of global greenhouse gas emissions. Central to deep decarbonization.
- AI is already helping decarbonize the power sector, including by:
  - optimizing location of generation and transmission
  - increasing output at solar and wind farms
- AI can do much more
  - dynamic line rating
  - optimal power flow analysis
- Barriers include:
  - lack of standardized data
  - lack of trained personnel
  - utility business models and culture
- Using AI in real-time operations creates security and safety risks.



Chapter 8: BUILDINGS

Roughly 1/4 of greenhouse gas emissions, throughout the building lifecycle — from design to steel and cement manufacture to construction to operation to demolition.

AI can help in many ways:

- Improve building design
  - Optimize site placement and material choices
- Reduce emissions during construction
  - Improve waste management and facilitate prefabrication methods
- Optimize building operations
  - Operate HVAC based on real-time building occupancy data
- Enable buildings to generate clean energy
  - Optimize solar panel placement

Chapter 13: **MATERIALS INNOVATION**

- New materials are vital for low-carbon technologies

- AI vastly reduces computing time for computational materials research
  - Summarize and integrate thousands of research articles
  - Search millions of possible materials
  - Identify tiny fraction worth physically testing
  - Pinpoint exact formula for production

RISKS

Use of AI can pose significant risks in several aress:

- **Content risks**
  - bias
  - invasions of privacy
  - misinformation/disinformation/ omission
- **Safety/security risks**
- **Resource risks**
  - increased greenhouse gas (GHG) emissions
  - strains on the power grid
  - water stress

Chapter 15B: DATA CENTER POWER DEMAND

In 2023, roughly 1.5% of global electricity demand came from data centers.

- US-3%; China-3.5%; EU-3.5%; Japan-1-2%.

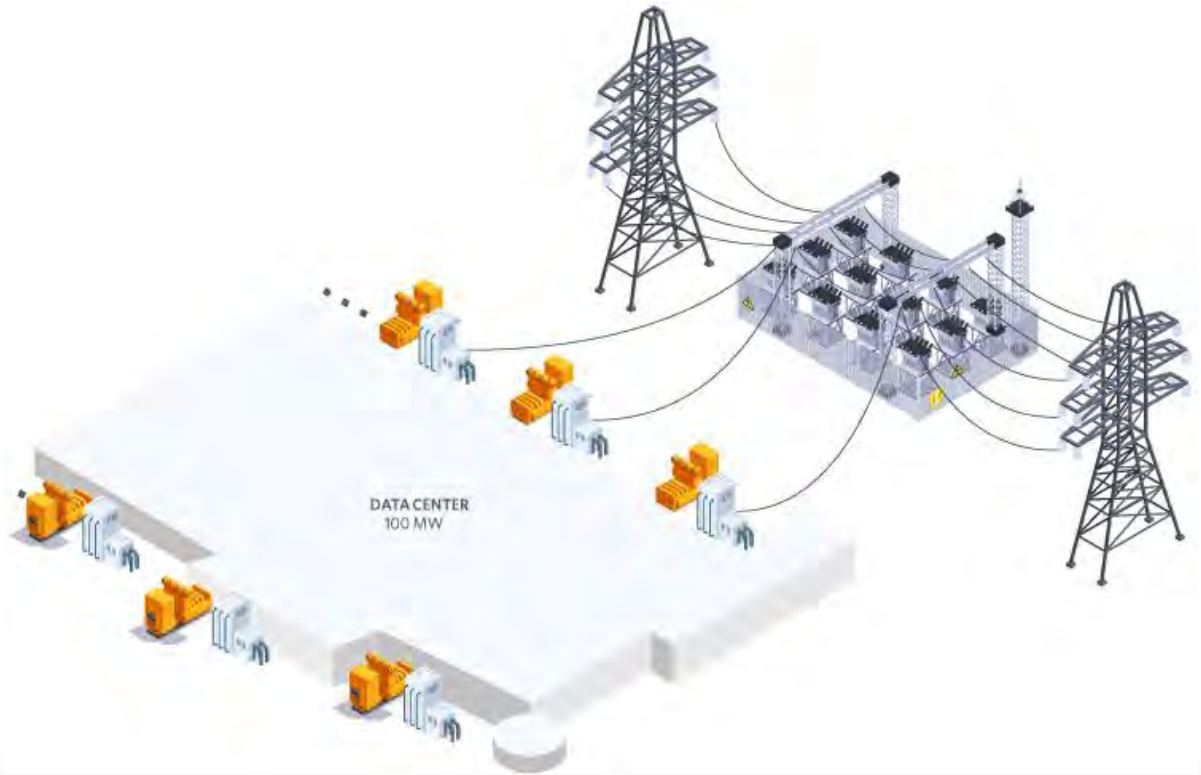
A comparison: 4% of global electricity demand came from aluminum smelters.

Data center power demand is growing fast

- Goldman Sachs Research projects 160% growth globally by 2030; many similar estimates

Data center demand growth is coming from many sources, not just AI.

- 5G networks, streaming services, social media and online gaming
- Yet AI is the most important factor.



Chapter 15: *Table 1. Power consumption projections for data centers*

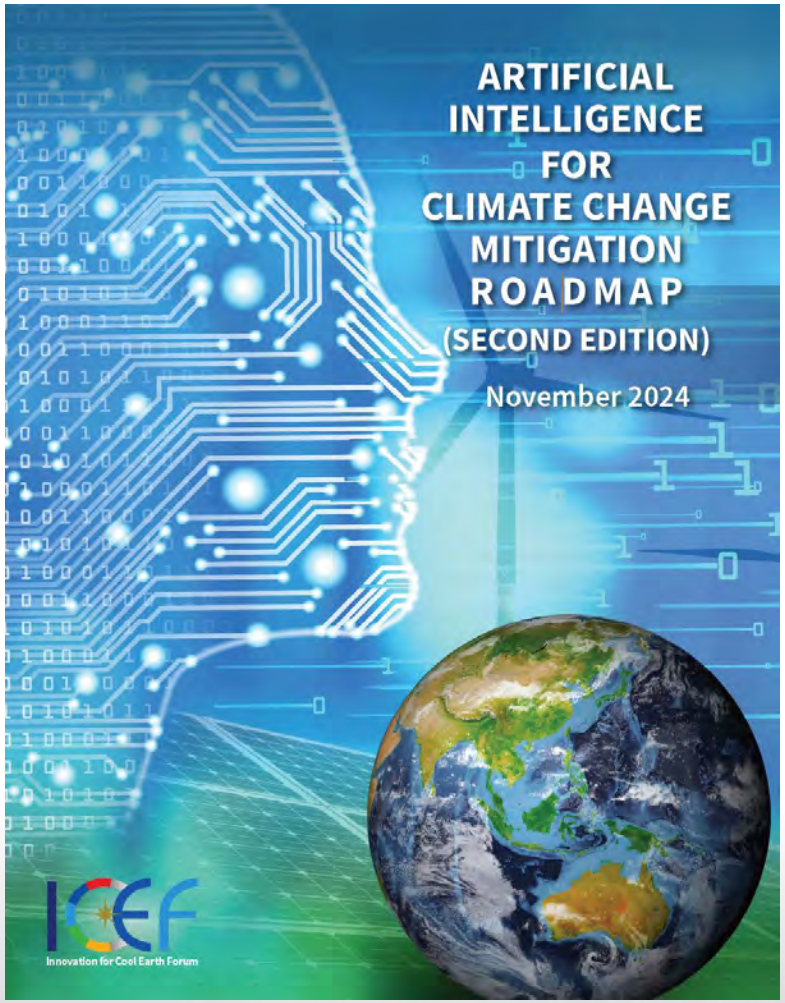
AUTHOR	PROJECTED ANNUAL GROWTH RATE	TIMEFRAME	REMARKS
Global			
IEA, Electricity 2024 (January 2024)[36] at p.31	21%	2022–2026	Electricity consumption by data centers, cryptocurrencies and AI globally increases from 460 TWh in 2022 to 620–1050 TWh by 2026
IEA, Electricity Mid-Year Report (July 2024)[19] at p.19	19%	2022–2026	Electricity consumption of data centers increases from 1–1.3% of global demand in 2022 to 1.5–3% by 2026
Goldman Sachs Research, 2024 (May 14, 2024)[15]	14.5%	2023–2030	Electricity consumption by global data centers increases from 411 TWh in 2023 to 1063 TWh in 2030; AI's percent of global data center load increases from 3% in 2023 to 20% in 2030 Data centers increase from 1–2% of global electricity consumption now to 3–4% by end of the decade
SemiAnalysis, 2024[37]	25%	2024–2030	Electricity consumption by data centers reaches 4.5% of global consumption by 2030
Morgan Stanley, 2024[38]	70% (GenAI only)	2024–2027	Global power usage from GenAI grows by 70% CAGR (compound annual growth rate) in 2024–2027 to 224 TWh

Chapter 17: FINDINGS AND RECOMMENDATIONS

RECOMMENDATIONS

1. *Governments, businesses and philanthropies should fund fora in which AI experts and climate change experts jointly explore ways AI could contribute to climate change mitigation.*

2. *Governments should assist in the development and sharing of data for AI applications that mitigate climate change and companies with datasets relevant to climate change mitigation should consider sharing portions of those datasets publicly.*

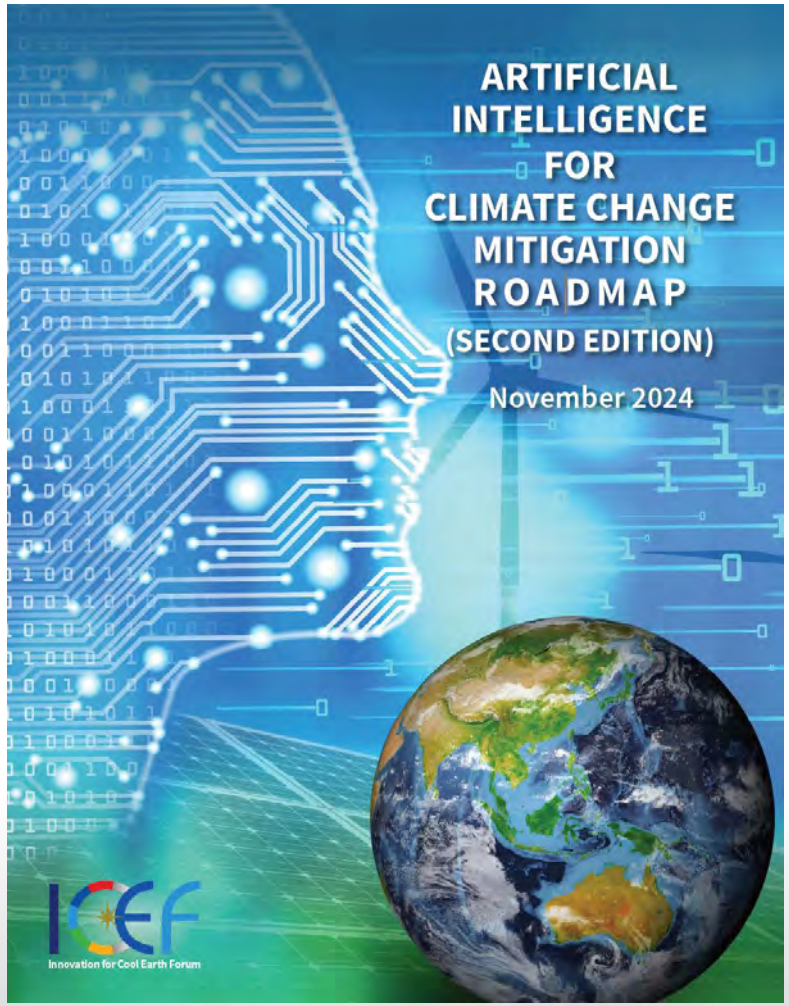


Chapter 17: FINDINGS AND RECOMMENDATIONS

RECOMMENDATIONS

3. Governments should require AI developers and data center operators to disclose GHG emissions associated with their AI operations on a full life-cycle basis.

4. Every organization working on climate change mitigation should prioritize AI skills-development and capacity-building.



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