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ICEF AI FOR CLIMATE CHANGE MITIGATION ROADMAP

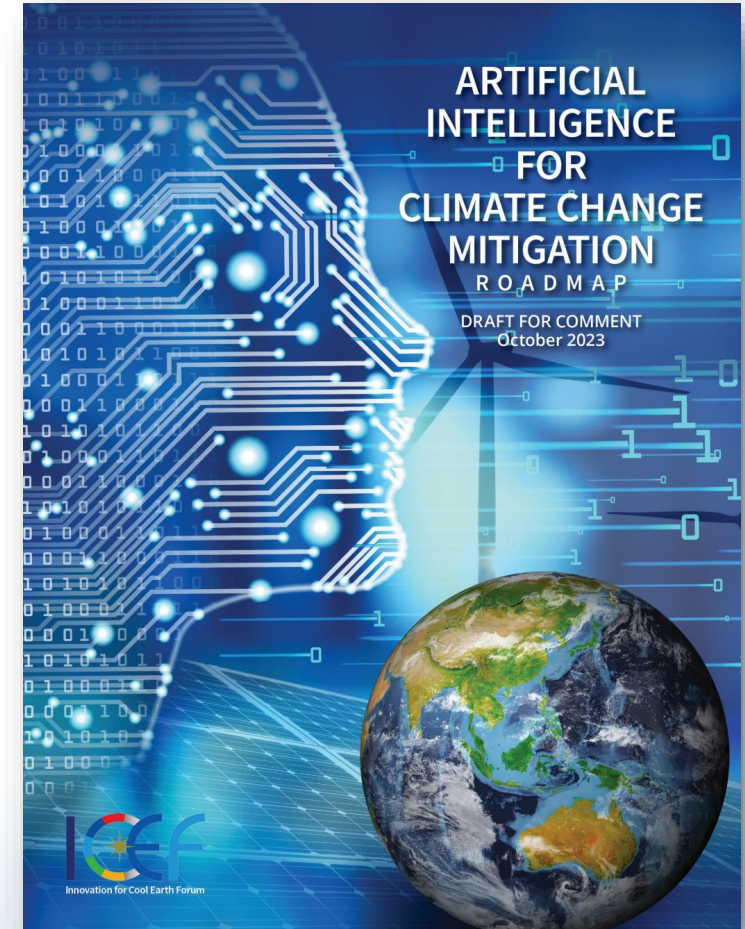
Topic:

- ***HOW CAN AI HELP REDUCE EMISSIONS OF GREENHOUSE GASES?***

(Not:

- *How can AI help adapt to climate change?*
- *On balance, will AI help or hinder the fight against climate change?)*

Send comments to ICEF2023Roadmap@gmail.com by October 31



ICEF AI FOR CLIMATE CHANGE MITIGATION ROADMAP

PART I: BACKGROUND

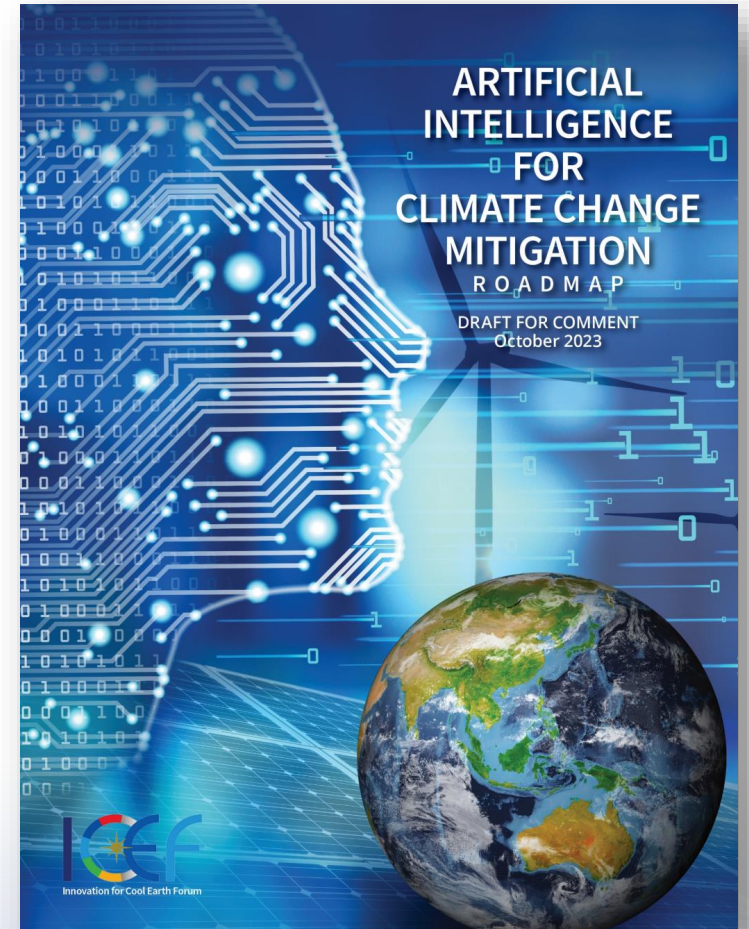
- Chapter 1. INTRODUCTION TO ARTIFICIAL INTELLIGENCE
- Chapter 2. INTRODUCTION TO CLIMATE CHANGE

PART II: HIGH-POTENTIAL OPPORTUNITIES

- Chapter 3. GHG EMISSIONS MONITORING
- Chapter 4. POWER GRID
- Chapter 5. MANUFACTURING
- Chapter 6. MATERIALS INNOVATION
- Chapter 7. FOOD SYSTEMS
- Chapter 8. ROAD TRANSPORT

PART III: CROSS-CUTTING TOPICS

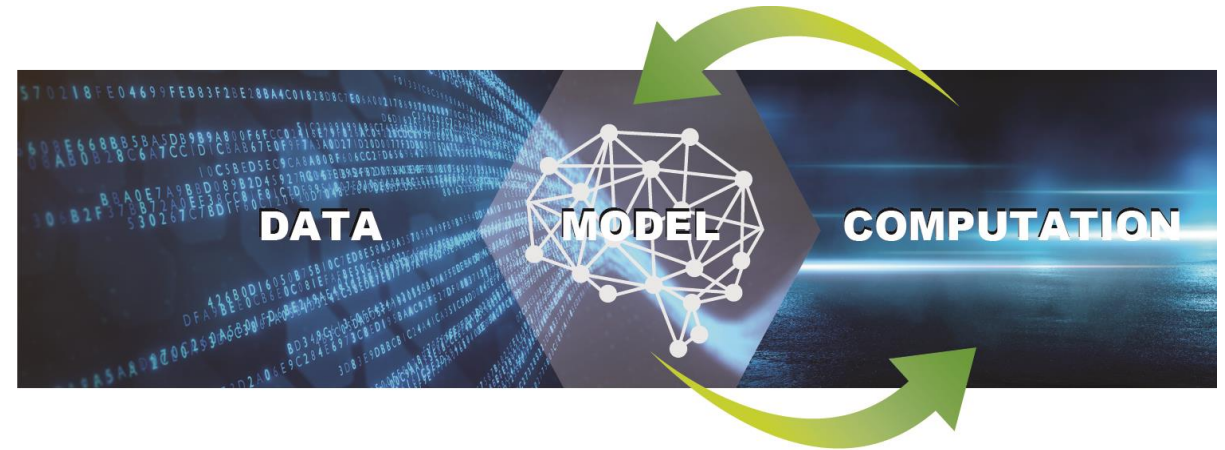
- Chapter 9. BARRIERS
- Chapter 10. RISKS
- Chapter 11. POLICY
- Chapter 12. FINDINGS AND RECOMMENDATIONS



Part I: BACKGROUND

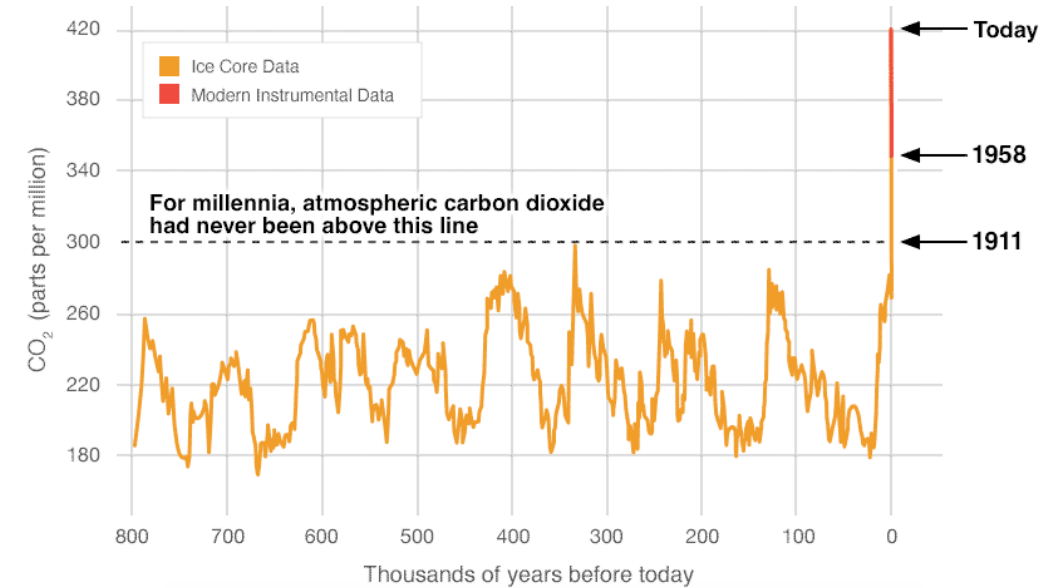
Chapter 1: INTRODUCTION TO AI

- Artificial Intelligence (AI) is the science of making computers perform complex tasks
- AI relies on machine learning (ML) to detect patterns from large datasets
- AI differs from traditional software
 - Instead of relying on explicit programming, AI relies on historical data and simulation to “train” models and “learn” patterns



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 6, 2023 was the warmest day ever recorded
 - July 2023 was the warmest month ever recorded
 - The warmest 9 years ever recorded were the last 9 years
- This summer's heat waves, drought, fires and floods are all consistent with scientists' predictions of the impacts of climate change.





Part II: HIGH-POTENTIAL OPPORTUNITIES

Chapter 3: GHG EMISSIONS MONITORING

AI is helping to significantly improve information on sources of greenhouse gas (GHG) emissions.

- *Analyzing vast amounts of data* from earth-observation satellites, airplanes, drones, land-based monitors, the Internet of things, social media and other technologies

AI has been particularly important in improving *methane emissions* monitoring.

- Processing data from methane sensors at scale
- Combining input from multiple satellites and other types of sensors

AI is also being used to better understand sources of *CO₂ emissions*.

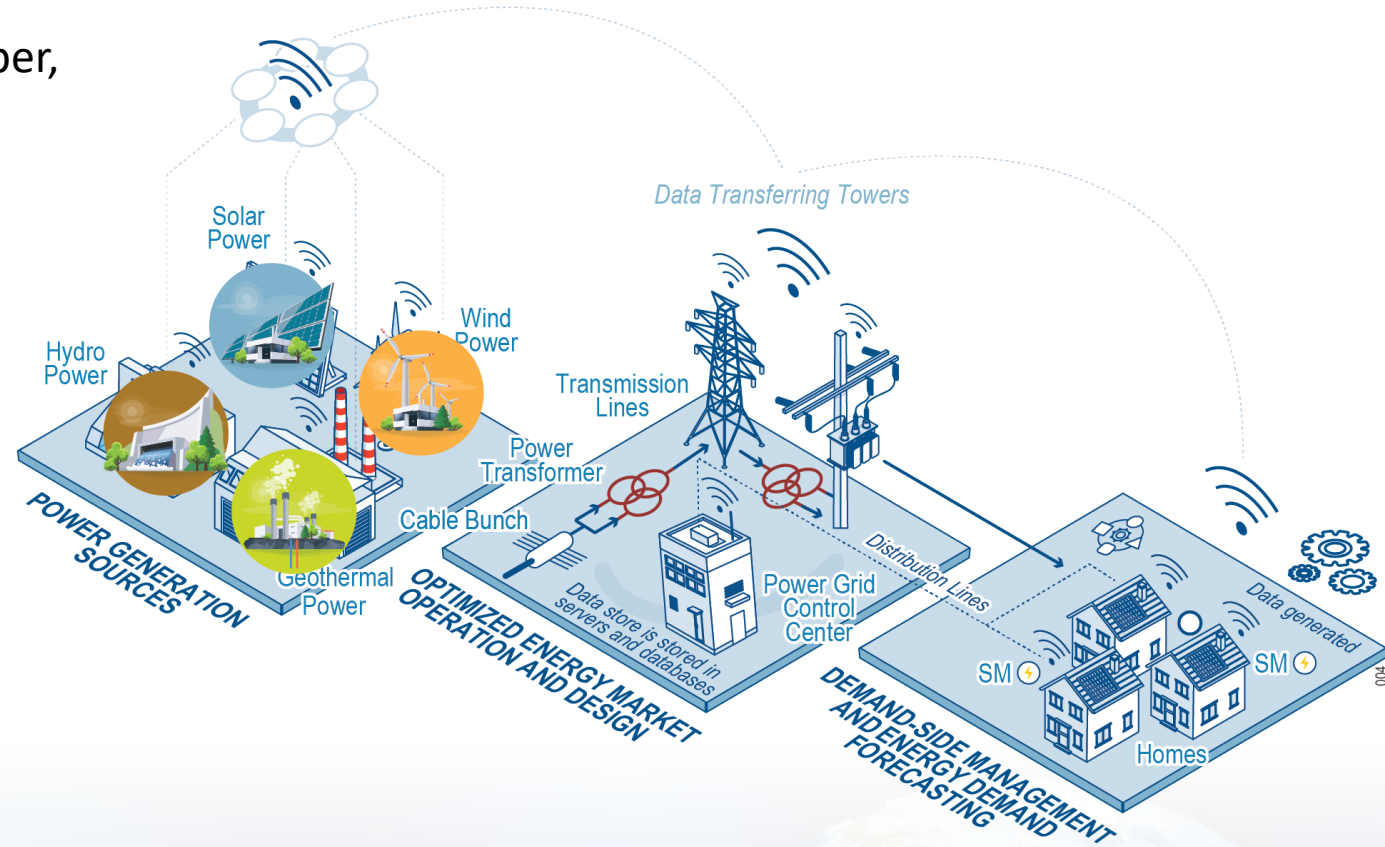
- AI algorithms can be trained to survey the world's vegetation at high spatial resolution.



Japanese IBUKI-2 GHG monitoring satellite

Chapter 4: POWER GRID

- AI is becoming an essential part of power grid infrastructure.
- AI can make decarbonization of the power grid cheaper, faster and smoother, helping with:
 - predictions,
 - scenario generation,
 - optimization, and
 - system planning and integration.
- AI can help in all parts of the power grid, including:
 - generation,
 - transmission and distribution
 - end use, and
 - energy storage.
- Barriers include:
 - lack of well-developed models, and
 - lack of trained personnel.
- Using AI in real-time operations creates security and safety risks.



Chapter 6: MATERIALS INNOVATION

- High-performance materials are essential for decarbonization
- Historically, new materials were discovered by accident or exhaustive, expensive experiments (e.g. Edison's light bulb).
- In recent decades, it has become possible to computationally predict whether new materials will have useful properties - but it is slow.
- AI can dramatically accelerate this capability
 - screen millions of possible materials for important properties,
 - dramatically accelerate materials experiments, synthesize published research, and
 - generate new materials concepts



Part III: CROSS-CUTTING ISSUES

Chapter 9: BARRIERS

Five groups of barriers impede the use of AI for climate change mitigation:

- data
- people
- computation
- cost
- institutions



Chapter 10: RISKS

Risks from AI can include:

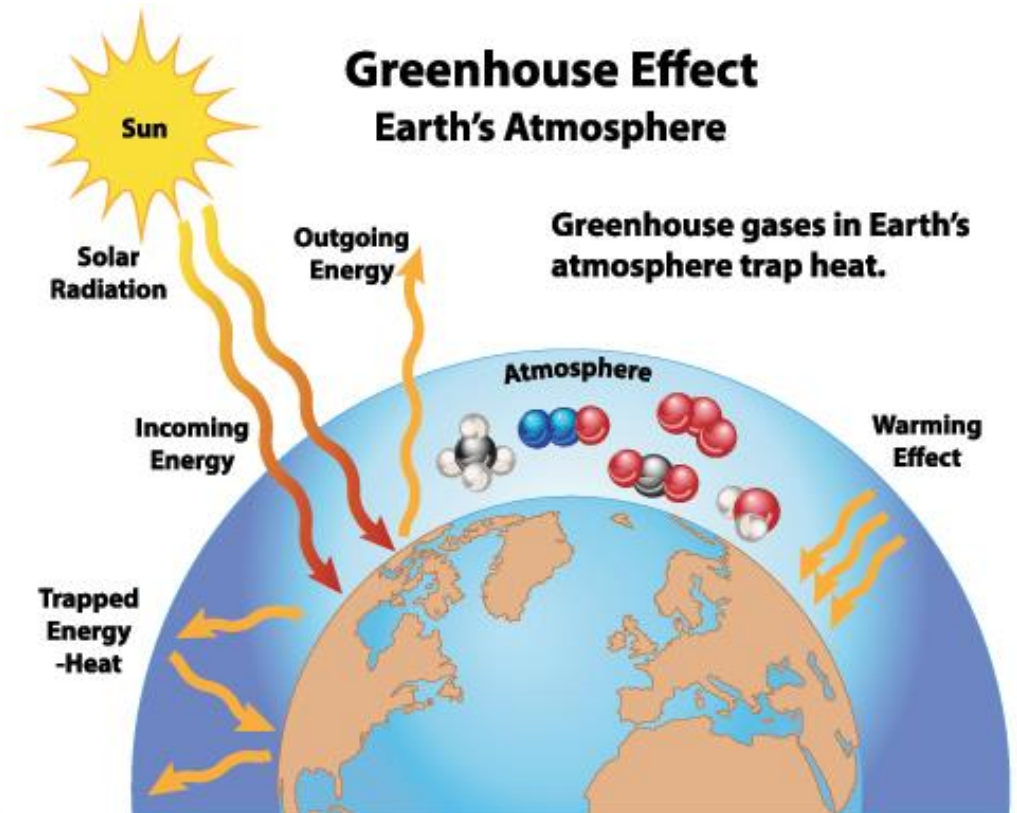
- bias,
- invasions of privacy,
- security threats,
- safety issues, and
- increased greenhouse emissions.

These risks exist when using AI for climate change mitigation.



Chapter 10D: GREENHOUSE GAS EMISSIONS FROM COMPUTING OPERATIONS FOR AI

- Currently modest—less than 1% of the global total and likely much less than 1% of the global total.
- Future GHG emissions are very uncertain—could be even more modest or could be substantial. Depends on:
 - processes used to manufacture AI equipment
 - energy efficiency of AI equipment
 - optimization techniques in AI models
 - use of zero carbon electricity in AI operations, and
 - demand for AI applications.
- Much better data collection and assessment methodologies are needed



Chapter 11: POLICY

Government policies with respect to AI are evolving rapidly, addressing topics including bias, privacy, security, safety and job displacement.

Very few policies that specifically address the use of AI for climate.

We explore two broad categories:

- *policies that promote* the use of AI for climate change mitigation, and
- *policies that manage risks* related to the use of AI for climate change mitigation

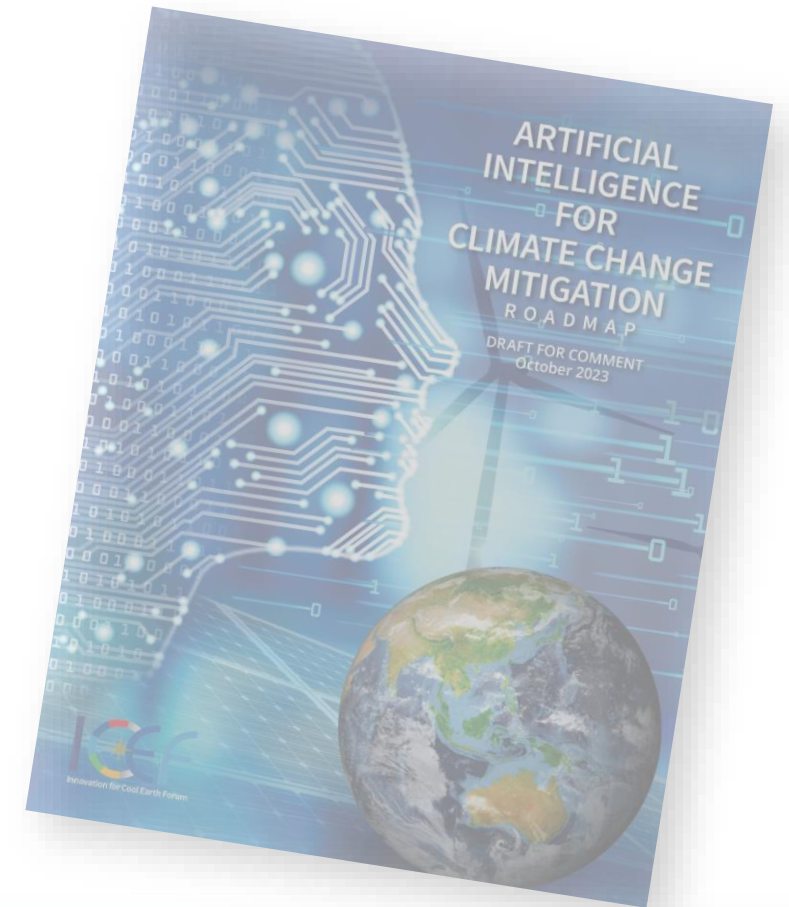


Chapter 12: FINDINGS AND RECOMMENDATIONS

FINDINGS

1. Artificial intelligence is currently contributing to climate change mitigation and has the potential to make significant additional contributions in the years ahead.
2. Artificial intelligence is not a panacea when it comes to climate change.
3. The lack of trained personnel and lack of high-quality data are critical barriers to the use of AI for climate mitigation.

[and five more]

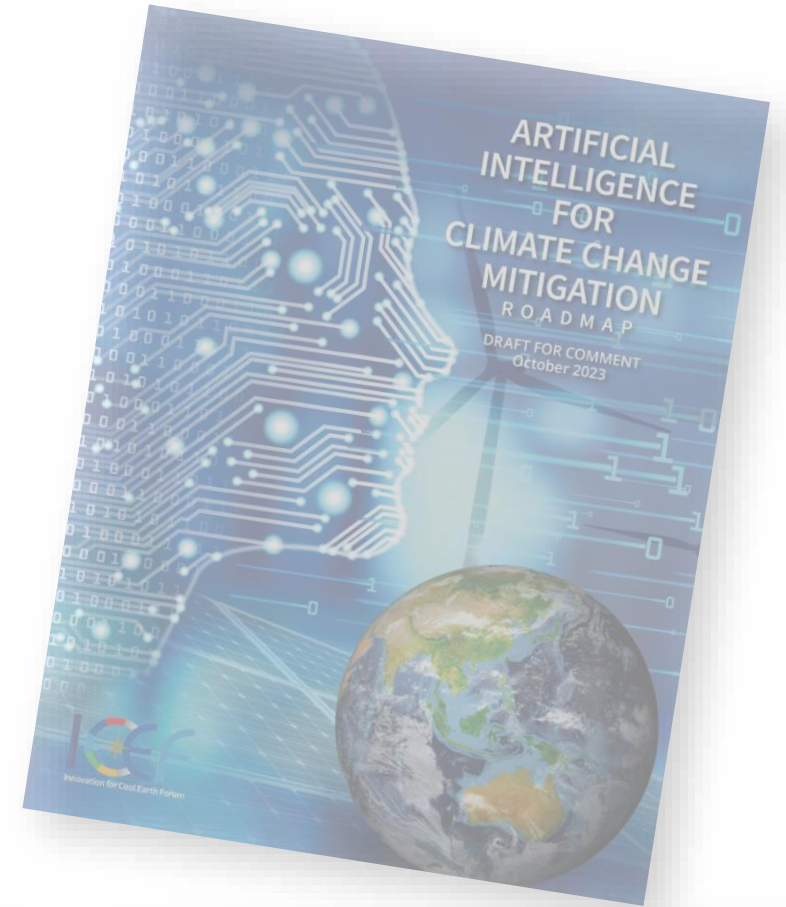


Chapter 12: FINDINGS AND RECOMMENDATIONS

RECOMMENDATIONS

1. AI tools should be integrated into many aspects of climate change mitigation.
2. AI skills-development should be a priority in all institutions with a role in climate mitigation.
3. Governments should assist in the development and standardization of data for AI applications that mitigate climate change.
4. All government agencies with responsibility for climate change should create an AI Office.

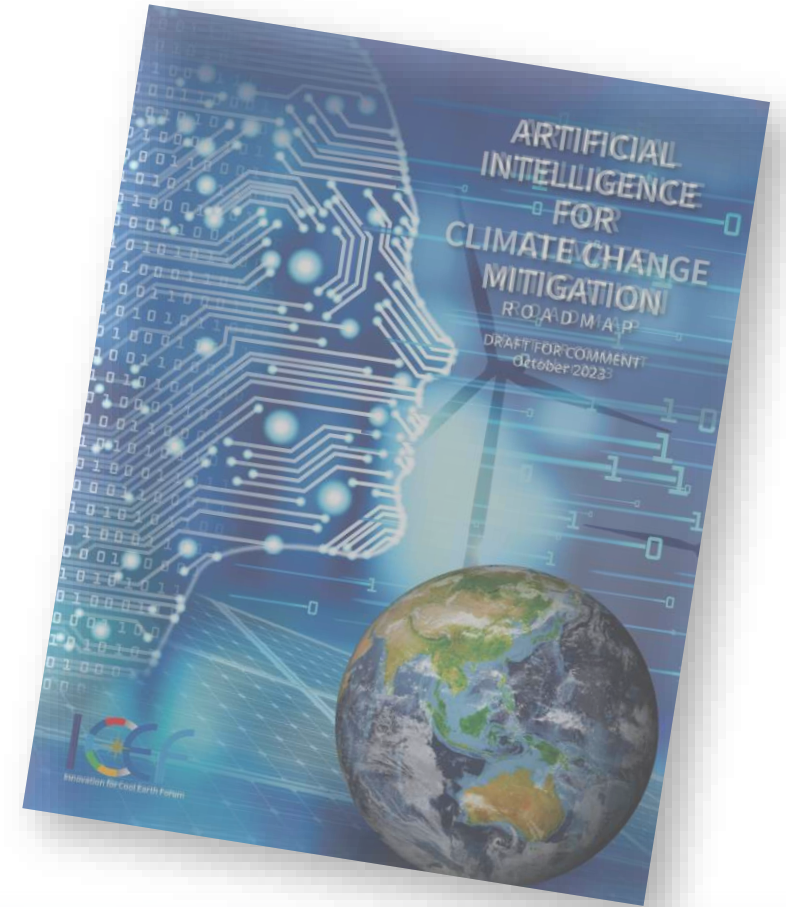
[and four more]



Chapter 12: FINDINGS AND RECOMMENDATIONS

RECOMMENDATIONS

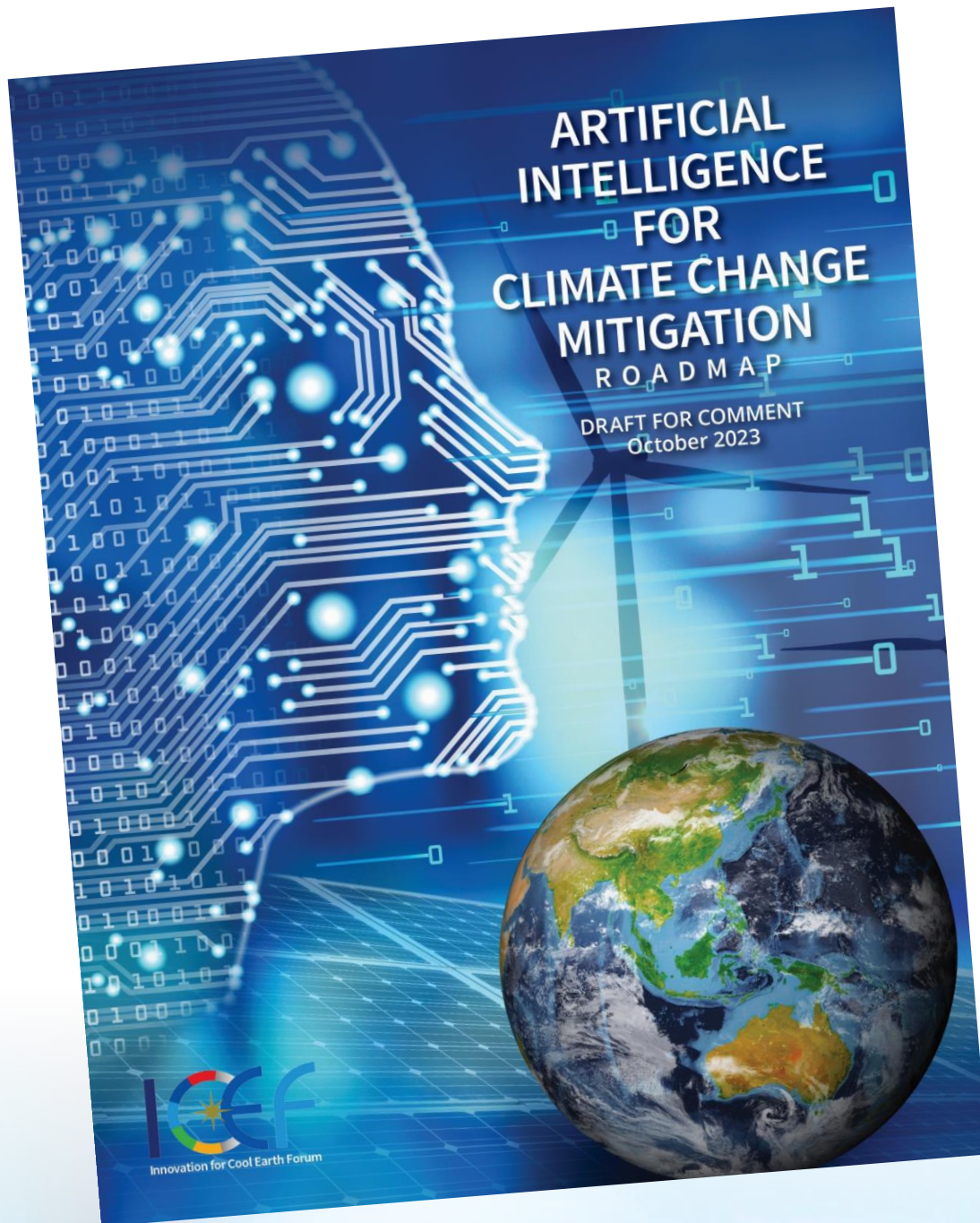
5. Electric utilities should be incentivized to deploy artificial intelligence, with regulated returns for investments in AI and other tools.
6. Governments should launch international platforms to support cooperative work on AI for climate change mitigation.
7. Governments should work to minimize greenhouse gas emissions from AI's computing infrastructure.
8. Avoiding unfair bias should be a core, high-priority principle guiding the development of all AI tools for climate change mitigation.



INNOVATION ROADMAP PROJECT

- Artificial Intelligence for Climate Change Mitigation
 - draft for comment released today
 - **send comments to ICEF2023Roadmap@gmail.com by October 31**
- Low-Carbon Ammonia (2022)
- Blue Carbon (2022)
- Carbon Mineralization (2021)
- Biomass Carbon Removal & Storage (BiCRS) (2020)
- Industrial Heat Decarbonization (2019)
- Direct Air Capture (2018)
- Carbon Dioxide Utilization 2.0 (2017)
- Energy Storage Roadmap (2017)
- Carbon Dioxide Utilization (2016)
- Zero Energy Buildings (2016)
- Solar And Storage (2015)





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