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# IEEJ Outlook 2026

## Future of AI and Energy Demand

The Institute of Energy Economics, Japan

**Naoko Doi**

**Asamu Ogawa, Songhee Kim, Taichi Kusayagi, Soji Koikari, Kagami Kotegawa,  
Kei Kobashi, Arina Sato, Toru Shimizu, Yi-chum Chen, Yu Nagatomi, Junya Nishi,  
Rino Hirose, Soichi Morimoto, and Atsutaka Yamada**



- **Interrelationship between energy and AI**
  - Recent trends on DC electricity demand
  - Outlook of DC electricity demand and saving potential
- **Use cases of AI for the demand side**
- **Energy savings potential of AI in the demand side: Outlook by 2035**
- **Implications**

# Background and Study Objectives

## ● Background

- **The close interrelationship between artificial intelligence (AI) and energy is attracting global attention.**
  - The growing use of generative AI and the advancement of digitalization will lead to a significant expansion of data centers.
  - Locally, there are concerns that the construction of power supply facilities will not keep up with the pace of data center construction.
- **AI is expected to bring significant benefits in key sectors related to energy use.**
  - Various energy-saving and CO2 emission reduction effects are expected
- **However, there are challenges to using AI on the demand side, such as a lack of awareness, human resources, and investment.**

## ● Study Objectives

- **To analyze the future electricity demand in data centres and its energy-saving potential.**
- **To analyze the energy-saving potential of AI in the demand sectors (industry, transport, commercial, and residential).**

# Interrelationship between energy and AI

# Was 2020 a turning point for data centres?

## Trends in Data Centres Electricity Consumption

## Global Data Centre Electricity Consumption and Data Volume

2015-2019

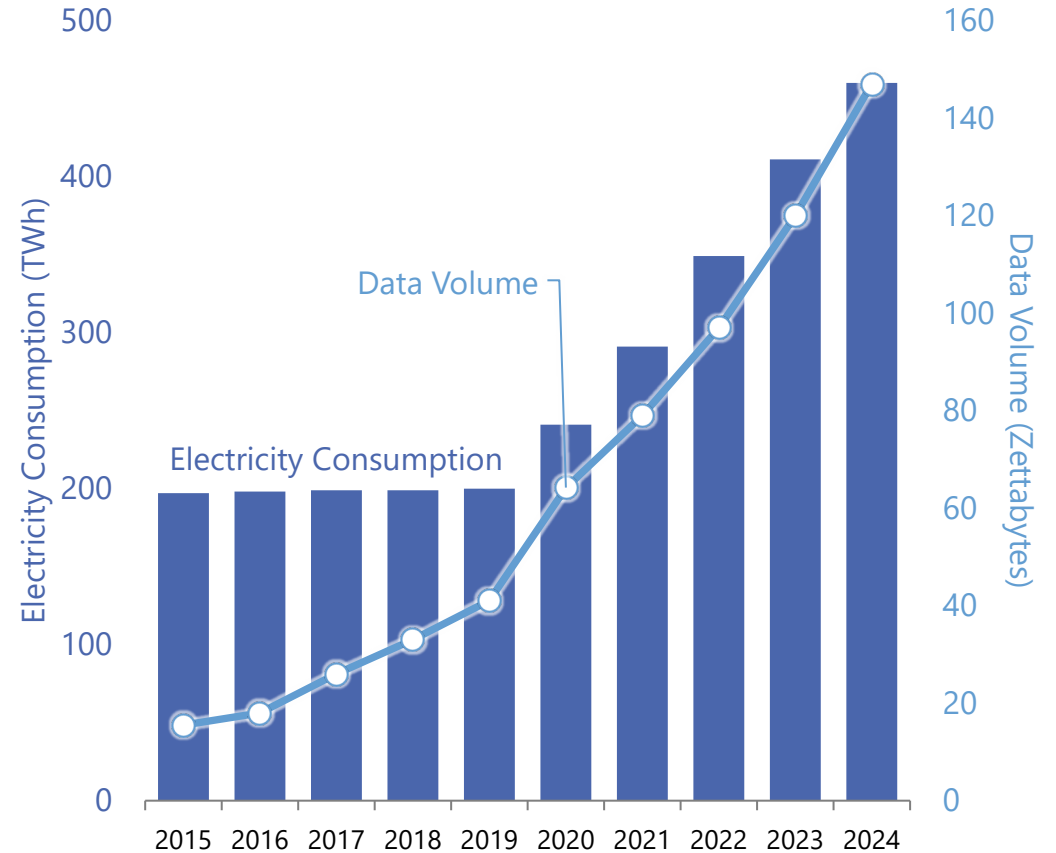
### Data center electricity consumption remained flat

- Data volume triples
- Energy efficiency advances in servers, storage, networking, infrastructure, etc.
- Shift from small data centers to large cloud and hyperscale data centers
- Improved efficiency of Graphics Processing Units (GPUs) contributes

After 2020

### Data centre electricity consumption increased by 70%

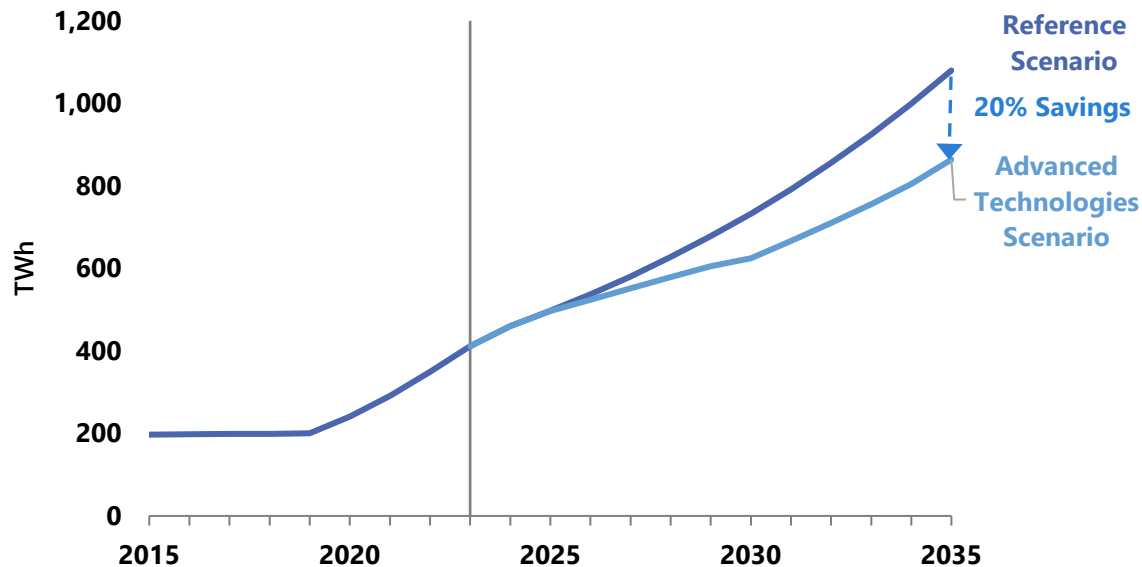
- The emergence of ChatGPT-3 and the expansion of generative AI use
- Advancing digitalization
- Increased use of cloud services due to the establishment of remote work
- Preparation for the construction of high-speed 5G equipment to cover unserved areas is underway



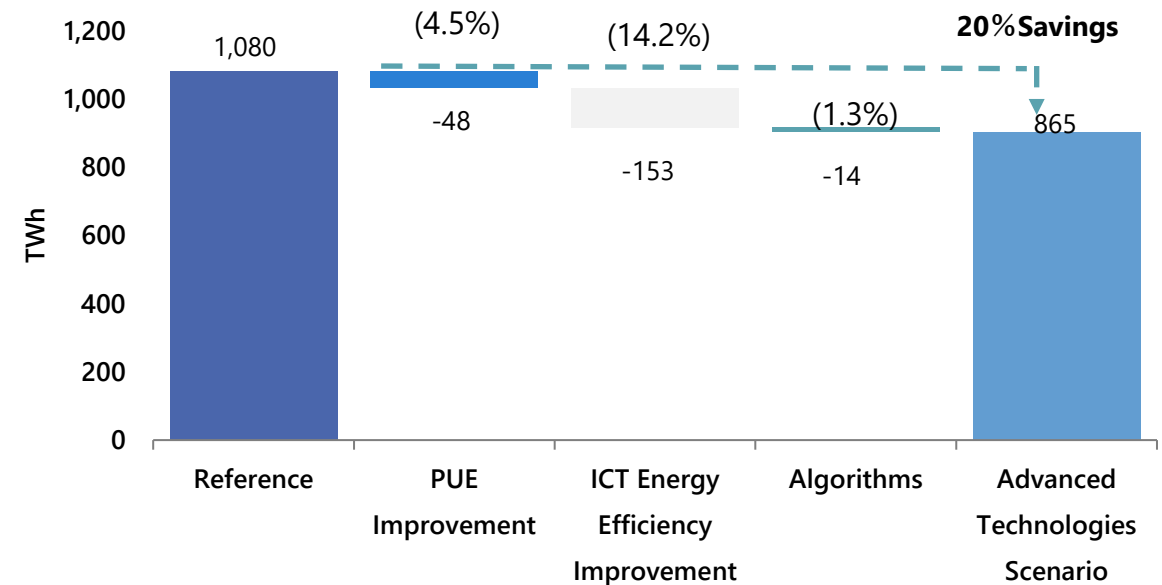
Source : Masanet et al. (2020), Cisco, IEA, Goldman Sachs Research,

# Data Centre has 20 % electricity savings potential (2035)

Data Centre Electricity Demand Outlook (2025-2035)



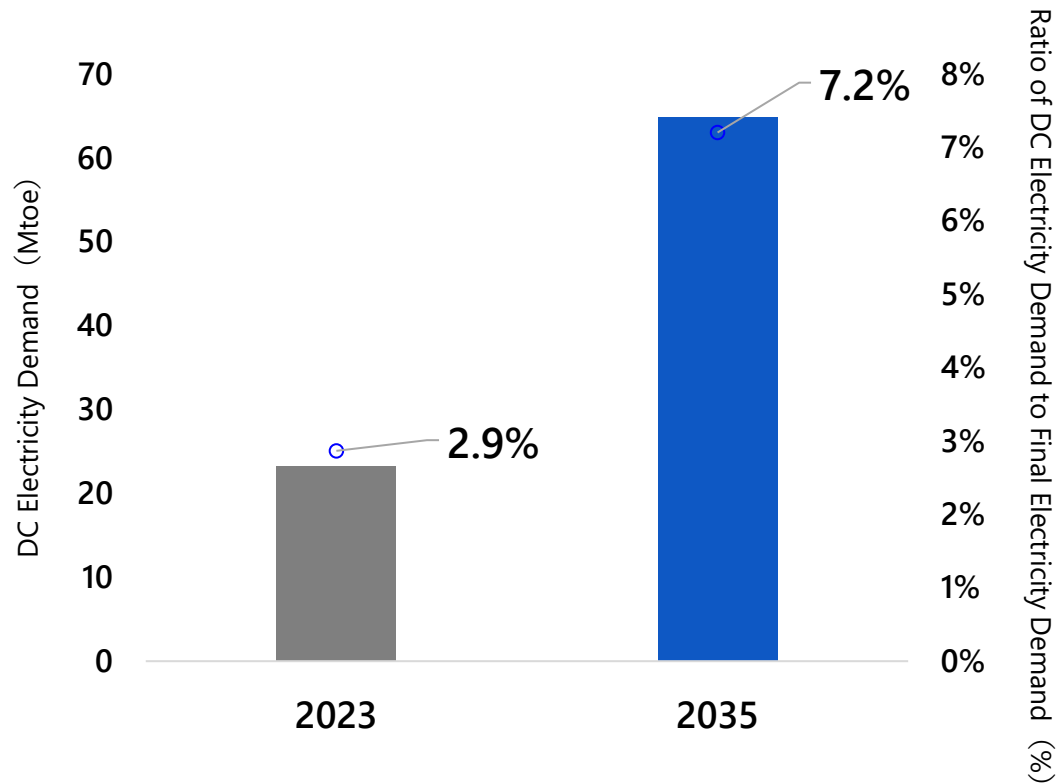
Data Centre Electricity Savings Potential (2035)



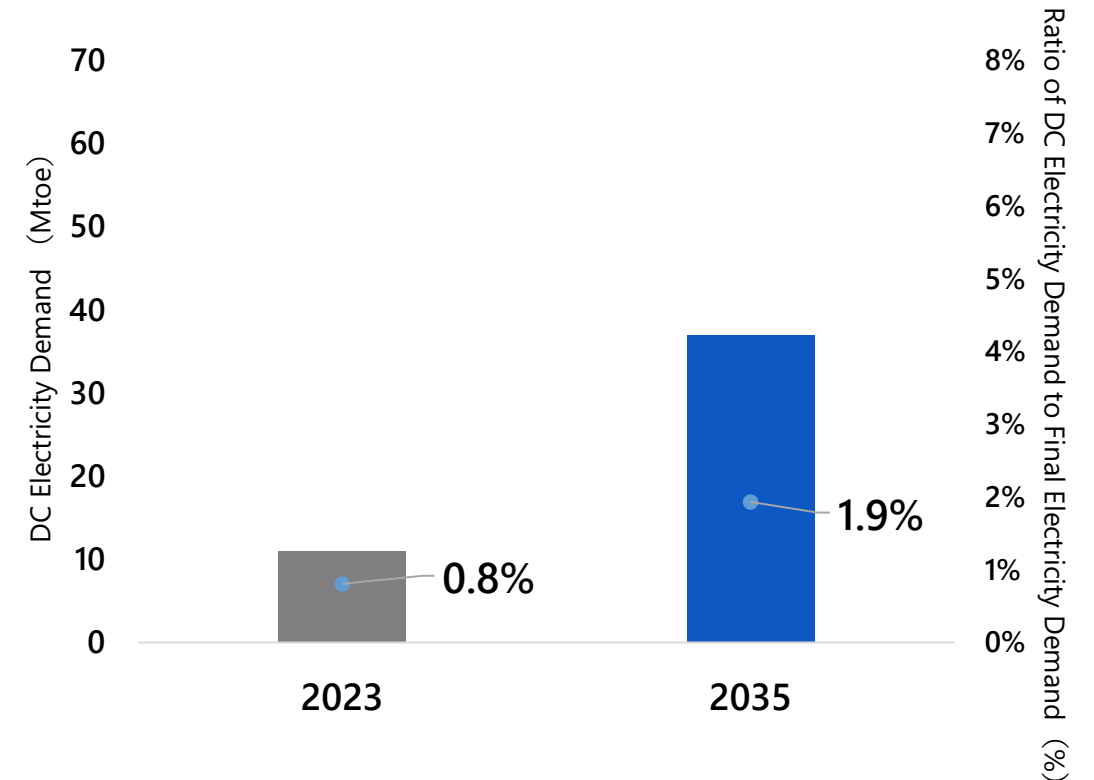
- Global data centre (DC) electricity demand is expected to **more than double from the current level of 497 TWh to 1,080 TWh by 2035.**
- Improving PUE through **high-efficiency cooling technology, ICT energy efficiency improvement** and **rationalization of algorithms will potentially save electricity demand by 20% by 2035.**

# DC electricity to double its share in final electricity demand (2035)

Advanced Economies



Emerging and Developing Economies



- In **developed countries**, the share of electricity demand from data centers (DCs) in final electricity demand will **increase from 2.9% (2023) to 7.2% (2035)**.
- In **emerging and developing countries**, the share will **increase from 0.8% (2023) to 1.9% (2035)**.

# Use cases of AI for the energy sector

# What contributions can we expect from AI for energy?

## Examples

<b>Detection</b>	<ul style="list-style-type: none"><li>▪ Automatic <b>detection of malfunctions</b> and other issues</li><li>▪ Remote sensing</li></ul>
<b>Prediction</b>	<ul style="list-style-type: none"><li>▪ <b>Weather forecasting</b> and renewable energy use</li><li>▪ <b>Industrial production forecasting</b> and building operation forecasting</li><li>▪ <b>Transportation demand forecasting</b> and vehicle route optimization</li></ul>
<b>Optimization</b>	<ul style="list-style-type: none"><li>▪ Optimizing <b>industrial production processes</b></li><li>▪ Optimizing energy usage in <b>buildings and equipment</b></li><li>▪ Improving fuel efficiency through <b>autonomous driving</b></li><li>▪ <b>Demand response</b> through energy supply and demand optimization</li></ul>
<b>Simulation</b>	<ul style="list-style-type: none"><li>▪ Simulations related to <b>identifying new materials</b> and <b>manufacturing new products</b></li><li>▪ Simulations of the effects of energy conservation and clean energy adoption</li></ul>

- AI is expected various benefits to the energy sector.
- This study conducted a **quantitative analysis of the energy savings potential of AI for optimization of the demand sector.**

# Energy savings potential of AI in the demand side : Outlook by 2035

# This analysis examines the energy savings potential of AI for the demand sector up to 2035.

Cases

Sector • Sub-sector • Technology

<b>Reference Scenario</b>	<ul style="list-style-type: none"> <li>✓ The trend of change will continue against the backdrop of current energy and environmental policies.</li> <li>✓ This does not mean that the status quo of policies, technologies, etc. will remain unchanged.</li> </ul>
<b>Advanced Technologies Scenario (ATS)</b>	<ul style="list-style-type: none"> <li>✓ Policies for stable energy supply and strengthening climate change countermeasures will be <b>vigorously implemented</b>, and <b>the introduction of low-carbon technologies</b> such as renewable energy and high-efficiency equipment will be <b>promoted to the maximum extent possible</b>.</li> </ul>
<b>AI Advancement Scenario</b>	<ul style="list-style-type: none"> <li>✓ The introduction of <b>AI for efficient energy use will advance energy savings</b> through new technologies and improvements to stock operations, in addition to ATS.</li> </ul>

## 1. Industry

- Iron and Steel, Cement, Petrochemical, Paper and Pulp, and Other industry

## 2. Residential

- Cooling/Heating, and Hot Water

## 3. Commercial

- Cooling/Heating, Ventilation and Lighting

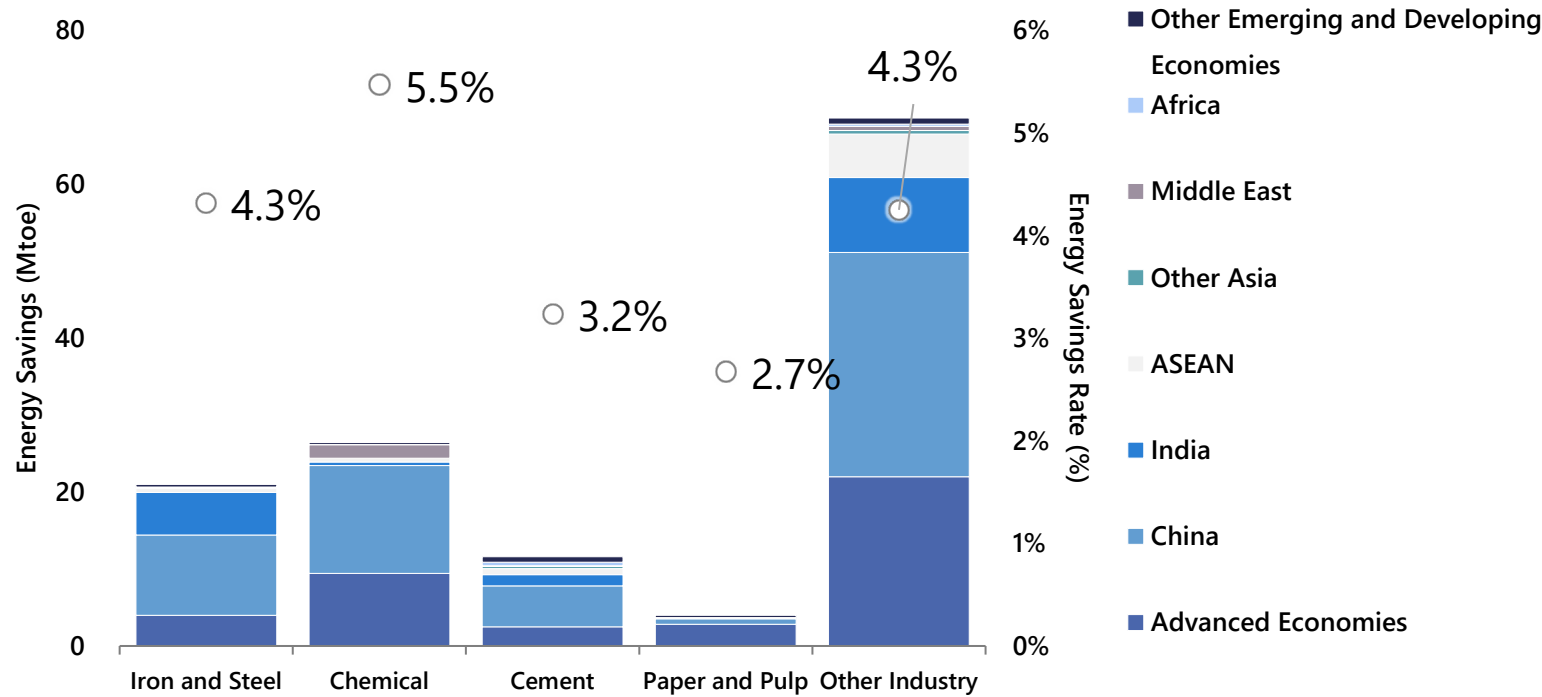
## 4. Road

- Passenger Vehicles, Buses • Trucks

**↑  
Estimation of Technical Potential Energy Savings**

# Use of AI has the potential to save 2-5% of industrial energy against ATS

Energy Savings Potential of AI and Energy Savings Rate (2035)

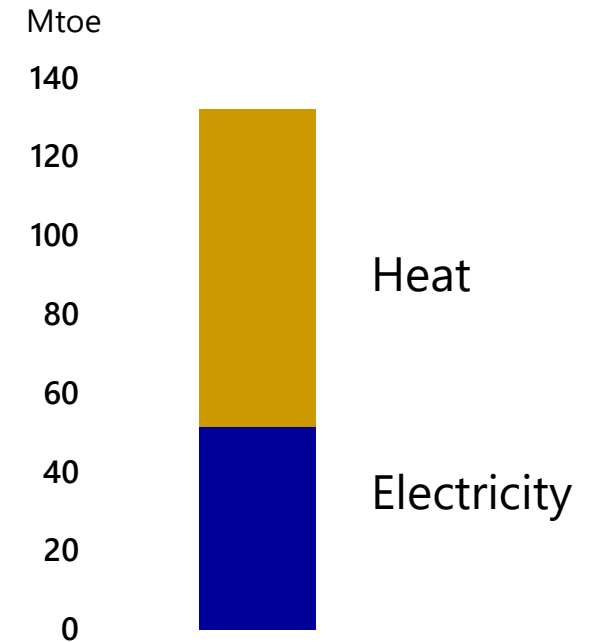
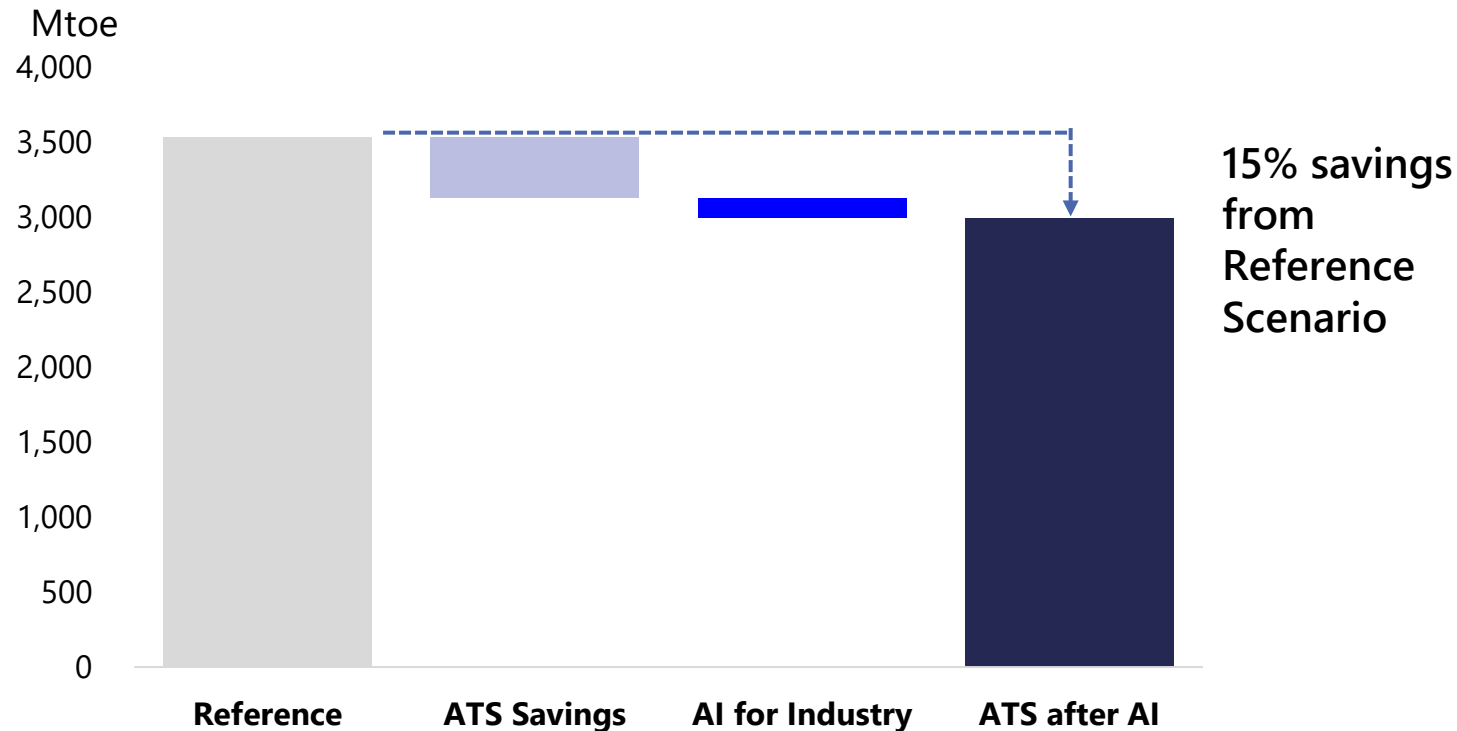


- Previously, **operational improvements were mainly based on the experience and knowledge of experienced operators**, but by **combining this with AI**, energy savings become possible through dynamic control based on **real-time predictions and an integrated approach that simultaneously optimizes multiple processes throughout the factory.**

# Coupled with advanced technologies and energy management, AI-enabled industries can achieve additional energy savings.

The Outlook for the Industry Sector (2035, World)

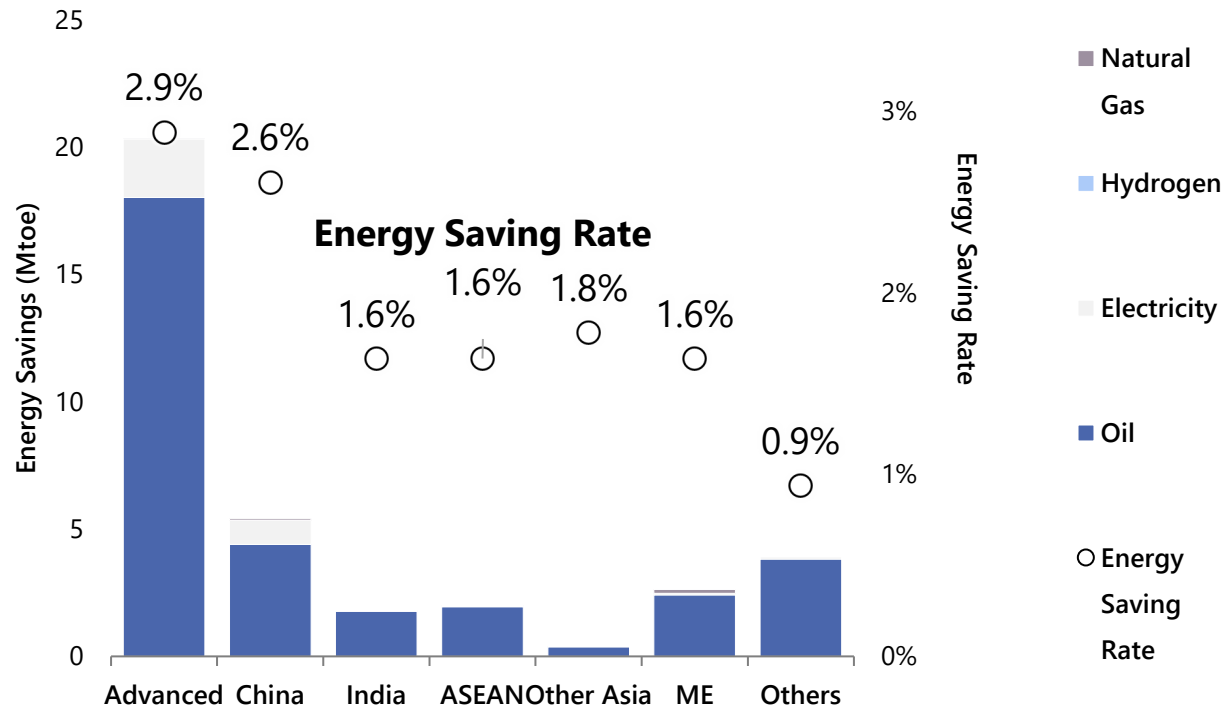
AI-enabled saving (2035, Industry, World)



# Energy saving potential of AI for road transport is estimated to reach 36.5 Mtoe in 2035

## Energy Savings Potential of AI and Energy Savings Rate [2035]

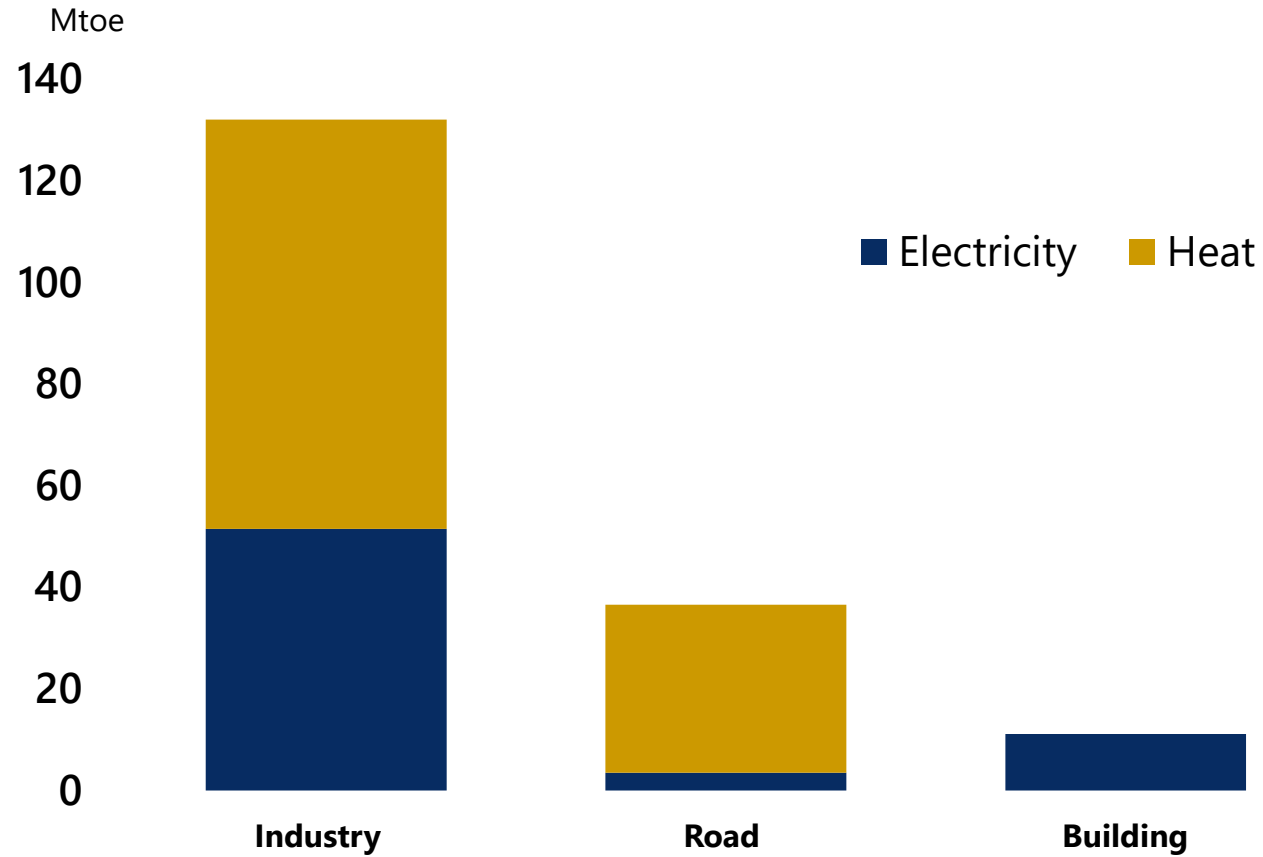
## Examples for Energy Savings of AI in the Road Transport



	Examples
<b>Demand Projection</b>	The loading efficiency and passenger efficiency of cargo trucks, buses, taxis, etc. can be improved by taking into account weather and traffic information.
<b>Route Optimization</b>	Through machine learning, AI suggests <b>route optimization</b> that takes into account the driver's travel preferences and, in the case of cargo trucks, delivery efficiency.
<b>Maintain distance between vehicles</b>	By maintaining a <b>constant distance between vehicles through autonomous driving</b> , vehicles can move without congestion, contributing to improved fuel efficiency. <b>Platooning</b> also reduces air resistance, contributing to improved fuel efficiency.

- ✓ Autonomous driving using AI is expected to improve fuel efficiency and optimize (shorten) travel routes.
- ✓ The energy saving potential of AI for passenger cars, buses, and trucks is estimated to reach 36.5 Mtoe in 2035 (0.9%-2.9% compared to ATS).

# AI-enabled system can save heat demand aside from electricity.



✓ Demand-side energy savings using AI have the technical potential to reach 178 Mtoe in 2035.

# Implications

- **The use of AI on the demand side has great potential for energy savings. By sector, the industry sector has the greatest impact on energy demand savings. However, various challenges remain in its widespread adoption and energy savings.**
  - ✓ Human resource development and awareness building
  - ✓ Providing incentives for increased adoption
  - ✓ Sharing of best practices
  - ✓ Cybersecurity measures
  - ✓ Measures against rebound effect
  
- **Of the estimated energy-saving potential of data centres, the contribution of improving ICT efficiency is relatively large.**
  - ✓ Additional evaluations (other than PUE) are required, such as measuring ICT efficiency improvements as an indicator of data centre energy savings.
  - ✓ Furthermore, cooperation is important involving a variety of stakeholders, such as data centre operators, semiconductor manufacturers and ICT-related manufacturers.