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Introduction

1. Cooling is Vital

The sector causes ~13% of global GHG emissions, mainly from HFC leaks and electricity use.

2. Climate Risk is Rising

Without action, cooling emissions could break the 1.5°C carbon budget within 30 years.

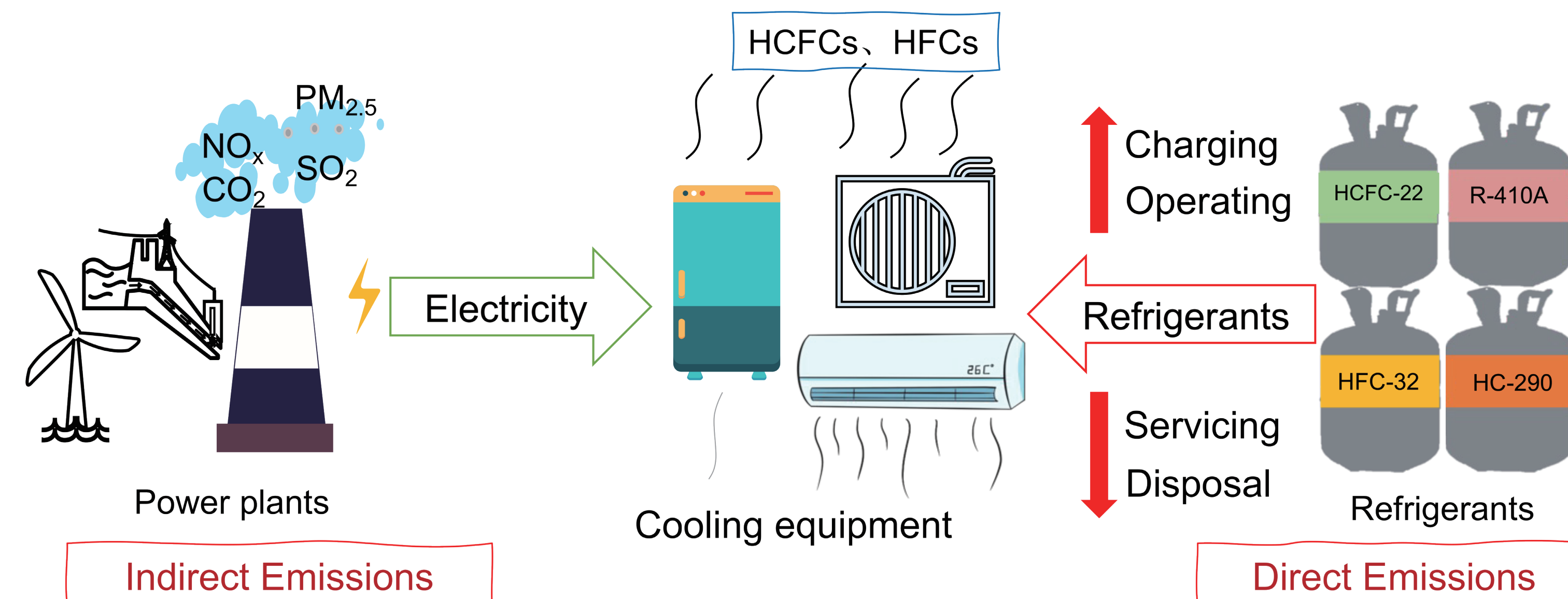
3. China Matters

China makes >80% of global room ACs; cooling uses ~15% of its electricity.

4. This Study

We assess China's main cooling sector to:

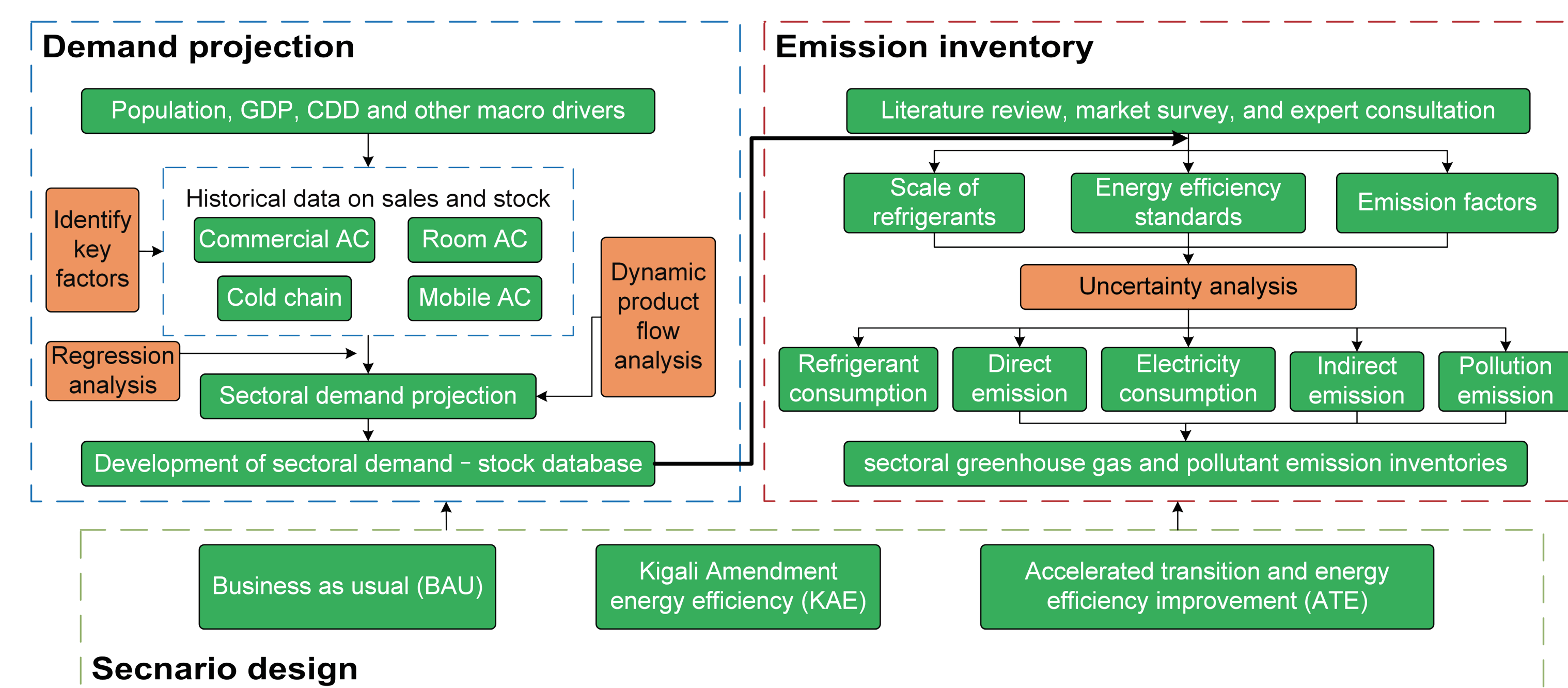
- Cut HFCs • Boost efficiency • Unlock climate and energy co-benefits.



Emissions from the Cooling Sector

Methods

Using the **RAC-DEC**^[1,2] model, we assessed future stock growth, refrigerant use, energy consumption, and emissions in China's cooling sector under BAU, KAE, and ATE scenarios from 2020 to 2060.



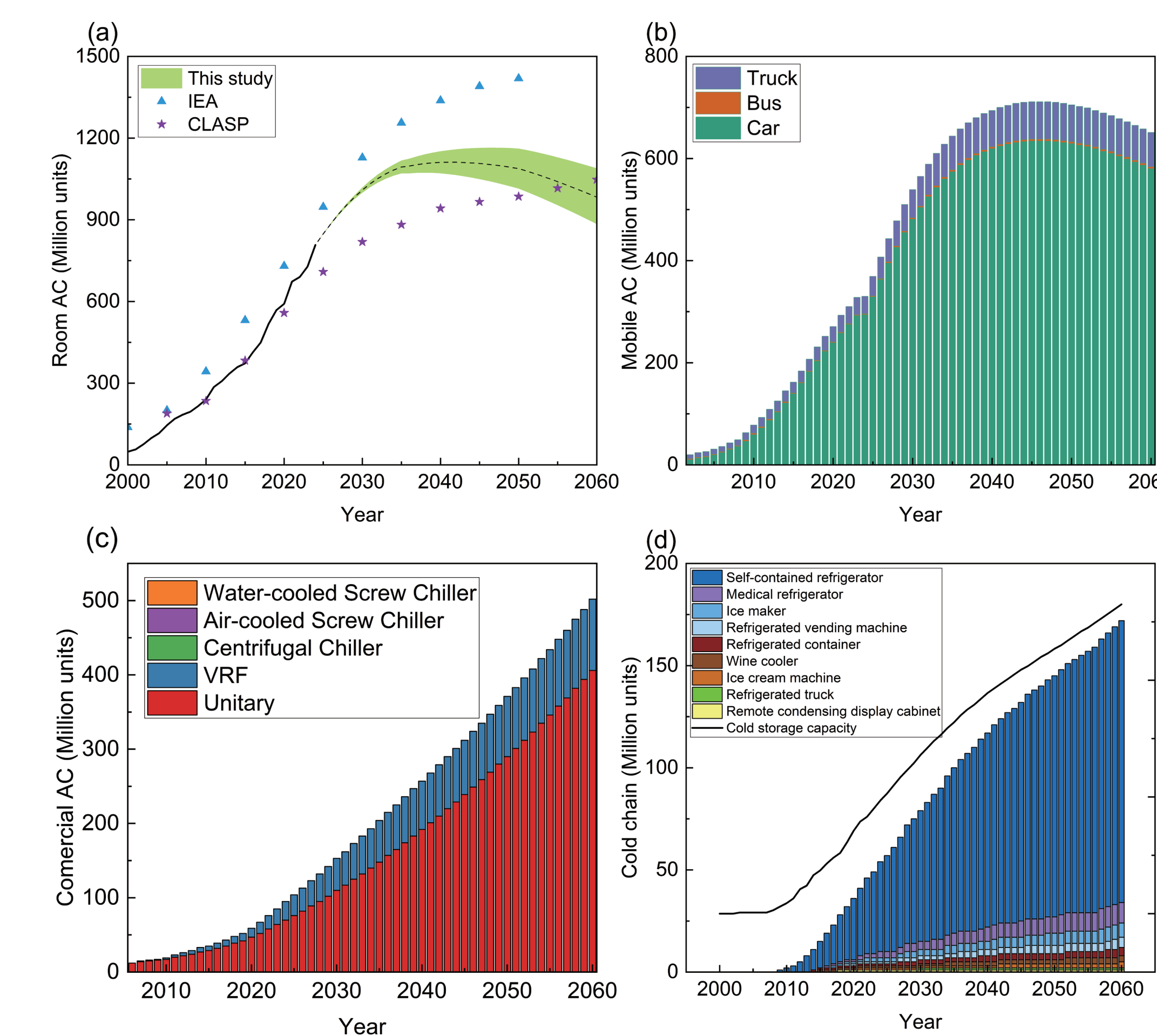
Modeling Framework of the RAC-DEC Model

Reference:

- [1] Jiang P, Bai F, Chen Z, et al. Exploring Synergistic GHG Emissions Mitigation Potential and Costs of Room Air Conditioners [J]. Environmental Science & Technology, 2024.
- [2] Jiang P, Li Y, Bai F, et al. Coordinating to promote refrigerant transition and energy efficiency improvement of room air conditioners in China: Mitigation potential and costs [J]. J Clean Prod, 2023, 382: 134916.
- [3] Cool Coalition. Global Cooling Pledge. 2023. Available at: <https://coolcoalition.org/global-cooling-pledge/>

Results

1. Projected Stock by Cooling Sector in China



(a) Room AC:

Stock rises from ~100 million in 2010 to peak at >1.2 billion by 2040, then slightly declines, reflecting market saturation.

(b) Mobile AC:

Grows to >700 million units by 2040, with cars as the dominant category throughout the period.

(c) Commercial AC:

Expands steadily to >500 million units by 2060, largely driven by unitary systems and VRF systems.

(d) Cold chain:

Reaches ~170 million units by 2060, led by self-contained refrigerators and refrigerated trucks.

2. Refrigerant Consumption and Direct Emissions

✓ HFC Consumption in 2022

- ~700 Mt CO₂-eq total, ~70% from cooling sector.

✓ Subsector Scope

- Room AC, Mobile AC, Commercial AC, and Cold Chain account for ~50% of use.
- Remaining from other RACHP sectors and servicing.

✓ Kigali Compliance Outlook

- No compliance pressure before 2040, led by Room AC improvements.

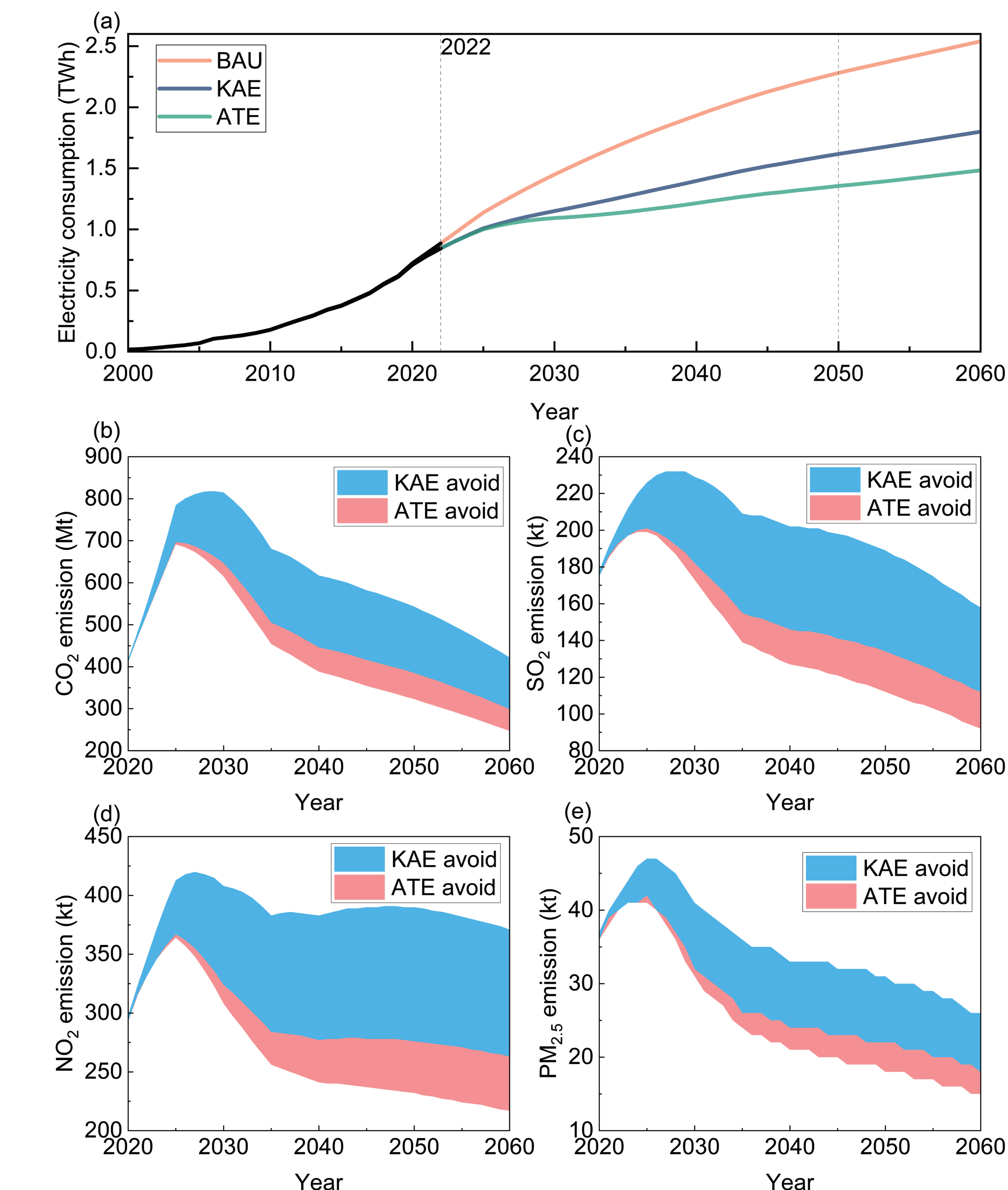
✓ Emission Trend by Subsector

- Room AC dominates emissions today; Commercial AC expected to lead after 2035.

✓ Cumulative Mitigation (2023–2060)

- KAE: ~6.7 ± 0.1 Gt CO₂-eq avoided.
- ATE: ~10.5 ± 0.2 Gt CO₂-eq avoided.

3. Electricity Use and Co-benefits under Different Scenarios



(a) Electricity consumption

Under the BAU scenario, electricity demand from China's cooling sector increases to ~2.5 TWh by 2060.

KAE and ATE reduce this demand by approximately 20% and 35%, respectively.

(b) CO₂ emissions

Emissions decline under both mitigation scenarios.

By 2060, ATE avoids nearly 250 Mt CO₂ annually compared to BAU, with a ~70 Mt CO₂ advantage over KAE.

(c–e) Air pollutant co-benefits under ATE by 2060:

- SO₂: reduced by ~90 kt
- NO_x: reduced by ~140 kt
- PM_{2.5}: reduced by ~27 kt

Conclusion

1. Explosive Growth Ahead

By 2060, room ACs exceed 1.2 billion, mobile ACs 600 million, commercial ACs 500 million, and cold chain stock expands sharply, driving refrigerant and electricity demand.

2. Cumulative Mitigation Potential

Without action, cooling emissions (2023–2060) exceed 38 Gt CO₂-eq. ATE cuts this by nearly 50%, down to ~20 Gt CO₂-eq.

3. Pathway to the Global Cooling Pledge

ATE achieves a 58% cut by 2050 vs. 2022. Meeting the 68% target set by the Global Cooling Pledge^[3]—which calls for a 68% cut in cooling-related greenhouse gas emissions by 2050 compared to 2022—requires faster HFC phase-down, efficiency gains, and grid decarbonization.

4. Strong Co-benefits Delivered

ATE reduces electricity by ~35%, saves >20,000 TWh, and cuts annual NO_x, SO₂, PM_{2.5} emissions.

5. Faster Action, Greater Benefits

Accelerated measures would unlock larger climate and air quality co-benefits.