Non-CO_2 GHG Mitigation Potential and Cost Curves in China

Lawrence Berkeley National Laboratory and National Climate Strategy Center

Key takeaways

- China's reported non-CO_2 GHG emissions of 2.0 Bt CO_2e, (2012 or 16.8% of China's total GHG emissions), ranks as the fifth largest emitter globally, and will grow significantly by 2050
- Industrial processes and agriculture are the largest drivers of future non-CO_2 GHGs growth
- Low cost mitigation potential is estimated to be about 40% by 2050
- By 2030, there are roughly 480 Mt CO_{2e} mitigation potential, with average cost of $1/ton CO_{2e}
- Largest non-CO_2 mitigation potential exists for methane for early years, then replaced by HFC-125 reduction

Introduction

- China's non-CO_2 greenhouse gas (GHGs) emissions are expected to grow rapidly due to changes in urbanization, consumer preferences, and behavior.
- China's national GHG inventory for 2012 (released in Dec. 2016) reported non-CO_2 GHG emissions of 2.0 billion metric tons (Bt) CO_2e, or 16.8% of China's total GHG emissions
- What are mitigation potentials and their associated costs?

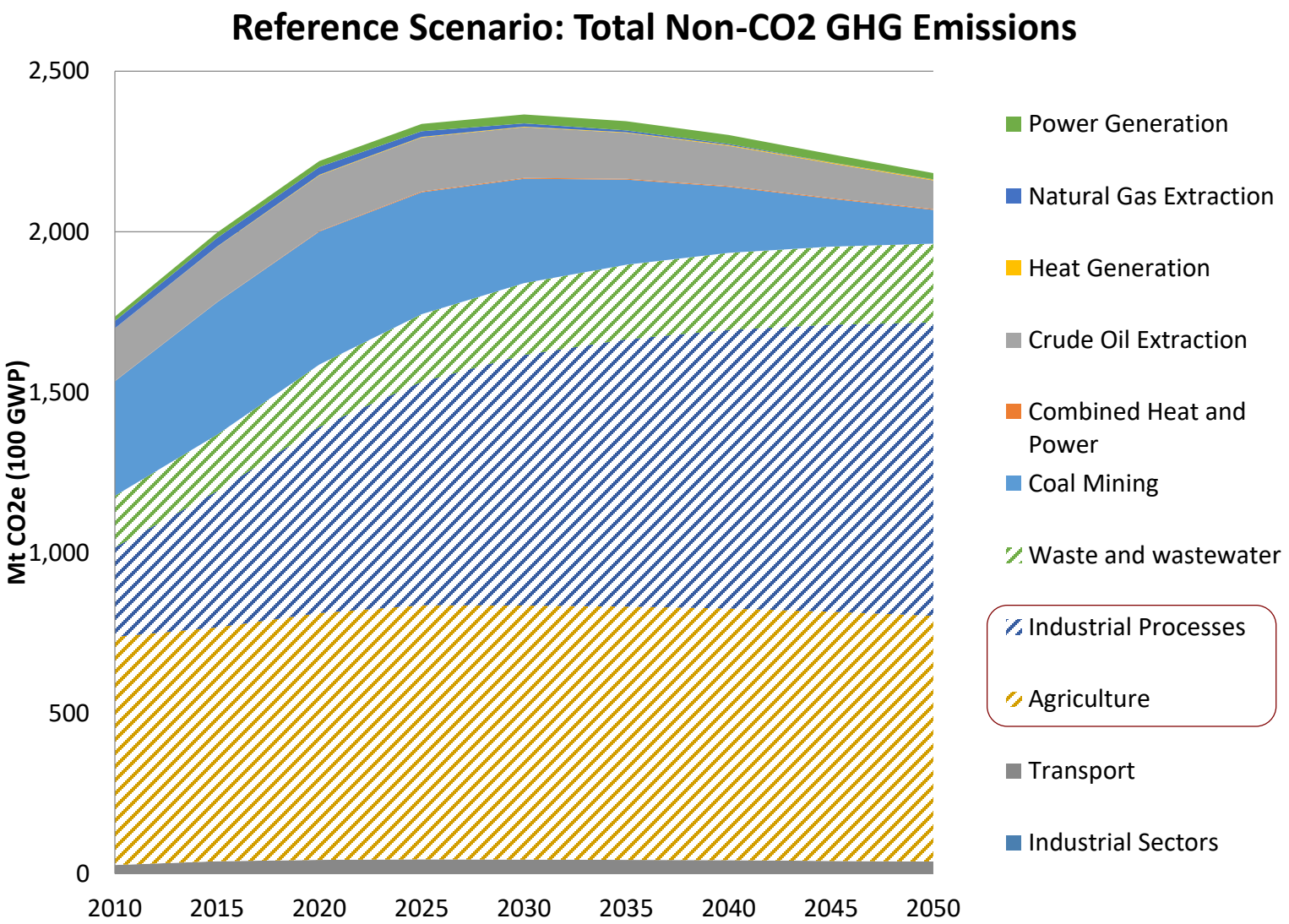
Modeling Study Overview

- **China 2050 DREAM has been under development for 10 years**
- **Two major, full economy 2050 reports have been issued using the model:**
  - 2010-2011 study – one of earliest modeling studies to show a peak and plateau in China's energy and CO_2 emissions at that time
  - Reinventing Fire: China – informed China's 13th FYP, INDCs, US-China negotiations running up to US-China Joint Announcement on Climate Change and the Paris Agreement
- **China 2050 DREAM also used for more specific policy assessments, including:**
  - Evaluation of sectoral policies in buildings, transport and power sectors
  - Evaluation of alternative energy sources, water-energy nexus
- **We added non-energy sector and non-CO_2 greenhouse gases (GHGs) into China 2050 DREAM for our analysis**

Scenario Analysis

- **Reference:** business-as-usual energy and emissions pathway in which only current policies continue to have impact and autonomous technological improvement occurs
- **CO_2 Mitigation:** considers lowered energy demand and CO_2 emissions due to full adoption of cost-effective efficiency and fuel switching by 2050; updated from Reinventing Fire: China study
- **CO_2 Plus Non-CO_2 Mitigation:** considers adoption of additional cost-effective and low-cost (below 20 $/tCO_{2e}$) non-CO_2 mitigation measures, with accelerated adoption after 2020

Non-energy sectors (industrial processes and agriculture) are the largest drivers of future non-CO_2 GHGs

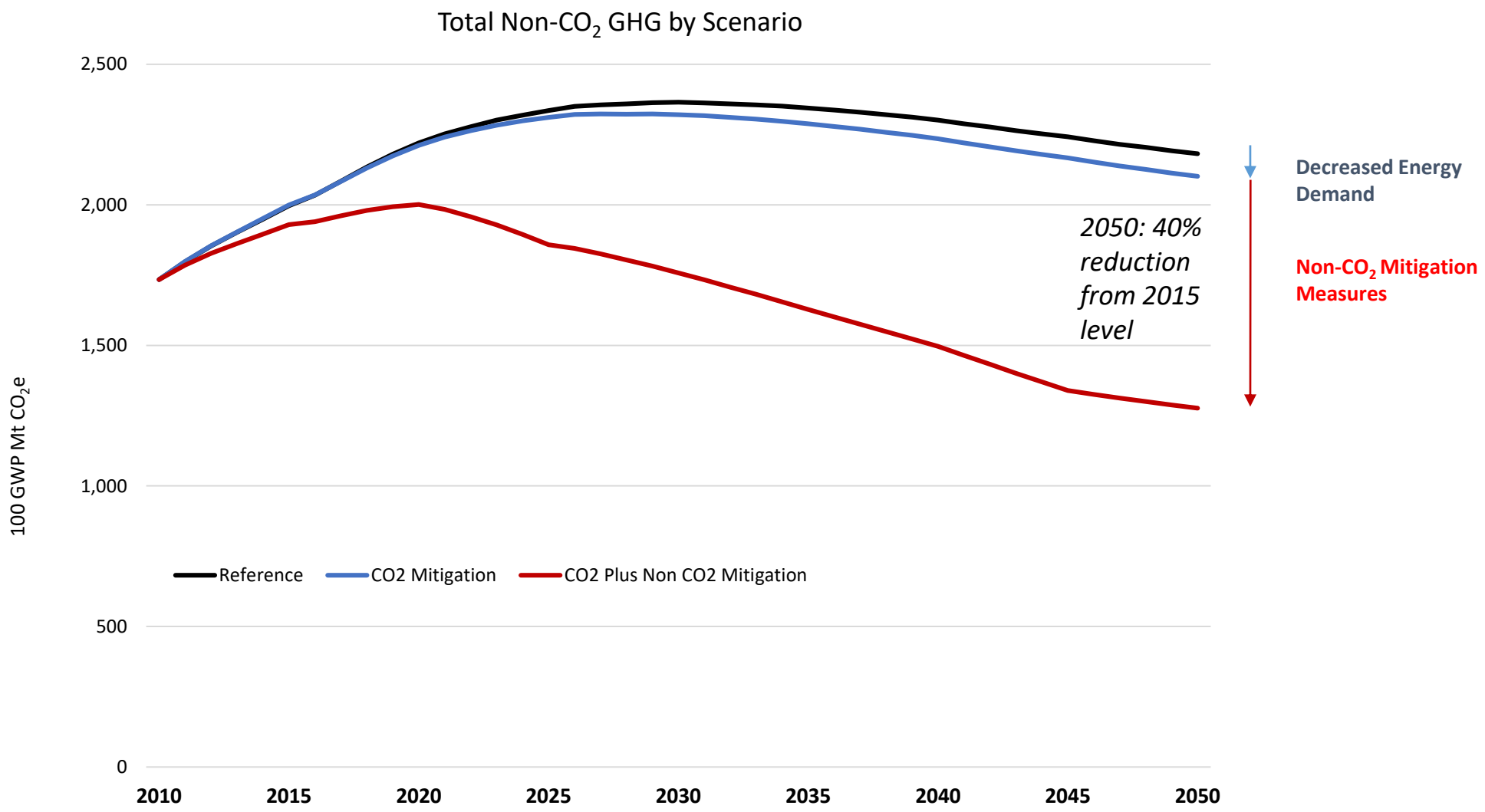


Summary of Preliminary Mitigation Scenario

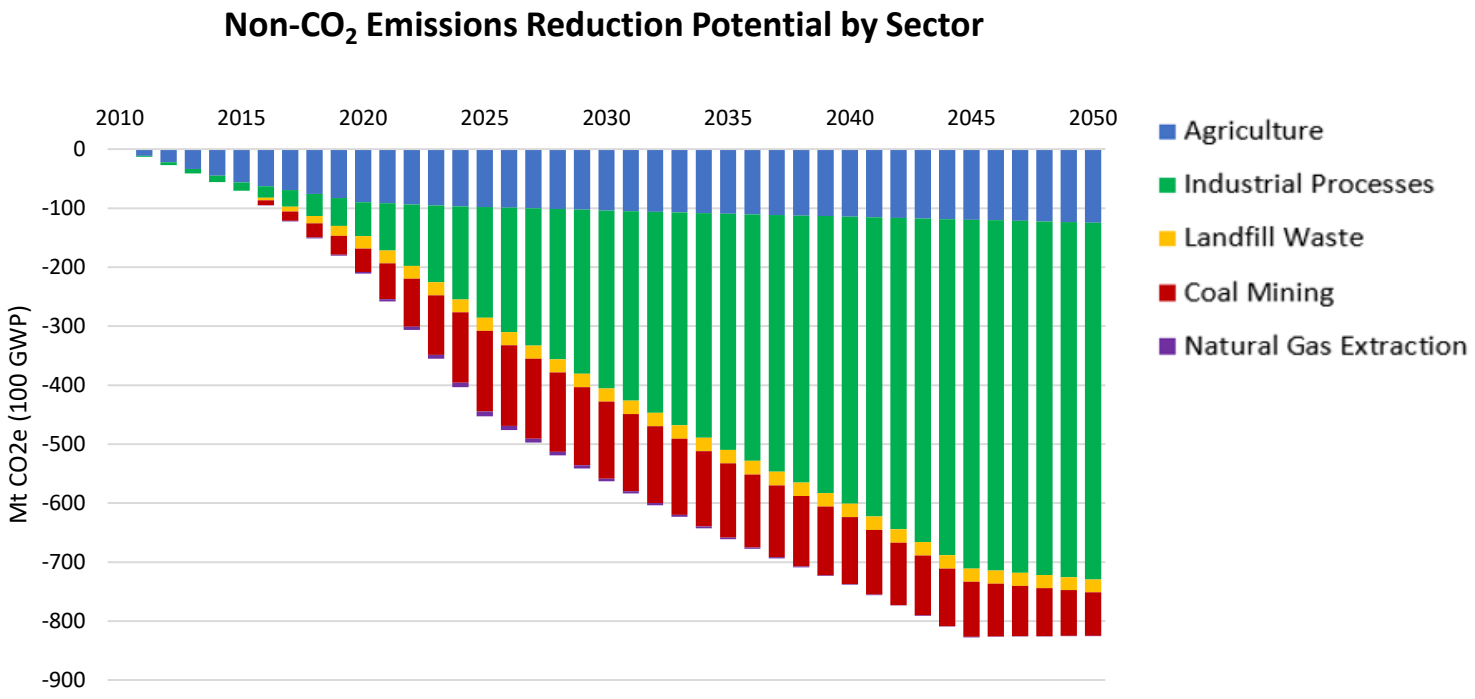
Based on literature and expert interviews, we quantified cost-effective and low cost (below 20 $/tCO2e) non-$CO_2$ mitigation measures for:

- Methane (CH4):
  - **Energy-related:** Coal Mining, Natural Gas Extraction and Transmission & Distribution
  - **Waste:** Landfill Waste
  - **Agriculture:** Rice Cultivation, Livestock Enteric Fermentation, Manure Management
- Nitrous Oxide (N2O):
  - **Agriculture:** Crop Management/Fertilizer
- HFCs: Mobile, Commercial, and Room ACs; Commercial and Industrial Refrigeration, HCFC-22 Production
- PFCs: Aluminum Production
- SF6: Power Generation

low cost mitigation potential of 40% reduction from in non-CO2 GHG emissions from 2015 by 2050



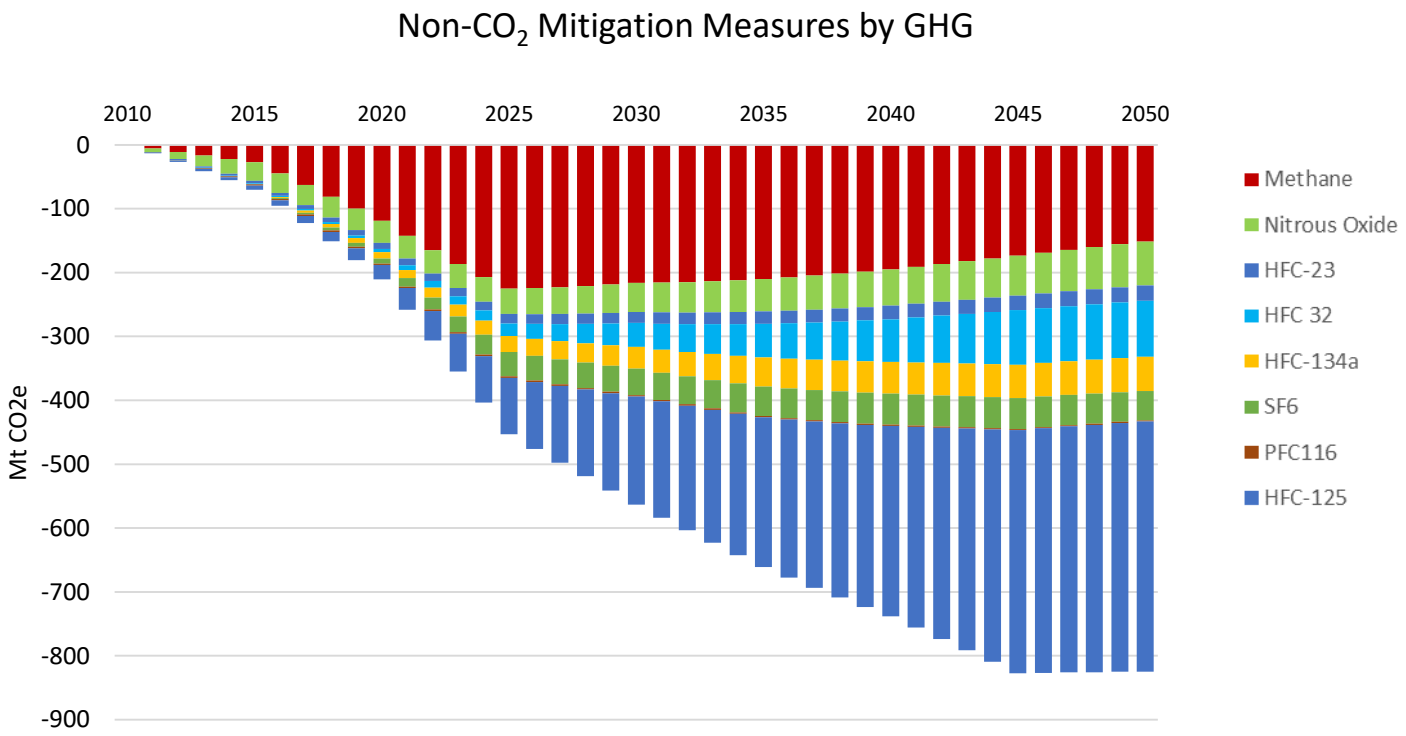
By sector, industrial processes hold largest mitigation potential, followed by agriculture and coal mining



Mitigation Reduction % of Total Emissions

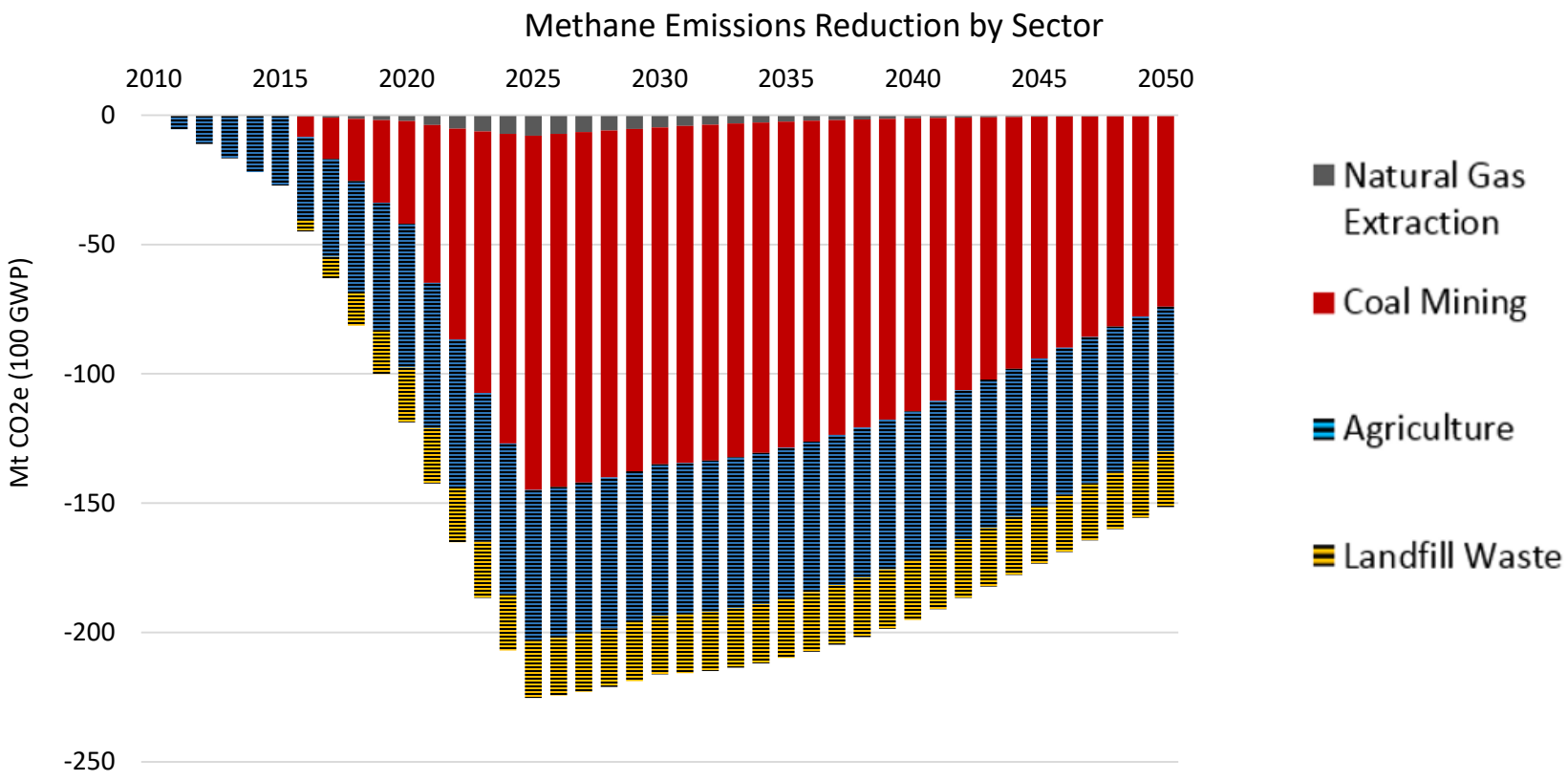
	2020	2030	2040	2050
Non Energy: Agriculture	-12%	-13%	-15%	-16%
Non Energy: All Industrial Processes	-10%	-39%	-57%	-68%
Non Energy: Waste and wastewater	-11%	-10%	-10%	-9%
Coal Mining	-10%	-40%	-55%	-70%
Natural Gas Extraction	-9%	-44%	-44%	-44%

Largest non-CO_2 mitigation potential exists for methane for early years, then replaced by HFC-125 reduction



	2020	2030	2040	2050
Methane	-9%	-18%	-19%	-17%
Nitrous Oxide	-6%	-9%	-11%	-14%
HFC-23	-80%	-100%	-100%	-100%
HFC 32	-10%	-50%	-80%	-99%
HFC-134a	-13%	-33%	-43%	-44%
SF6	-14%	-58%	-58%	-58%
PFC116	-15%	-15%	-14%	-14%
HFC-125	-10%	-49%	-76%	-93%

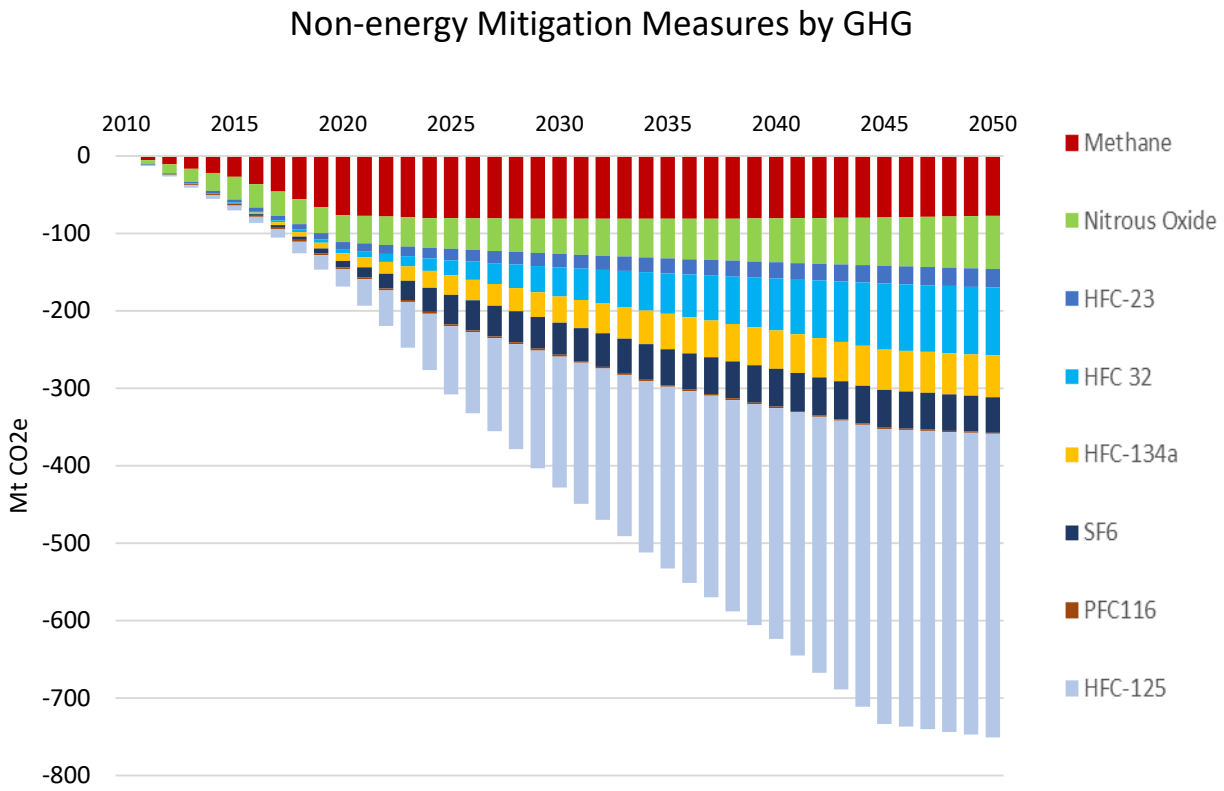
Largest methane mitigation potential is in coal mining and agriculture



Mitigation Reduction % of Total Emissions

	2020	2030	2040	2050
Natural Gas Extraction	-9%	-44%	-44%	-44%
Coal Mining	-10%	-40%	-55%	-70%
Non Energy: Agriculture	-12%	-12%	-12%	-12%
Non Energy: Waste and wastewater	-12%	-11%	-10%	-9%

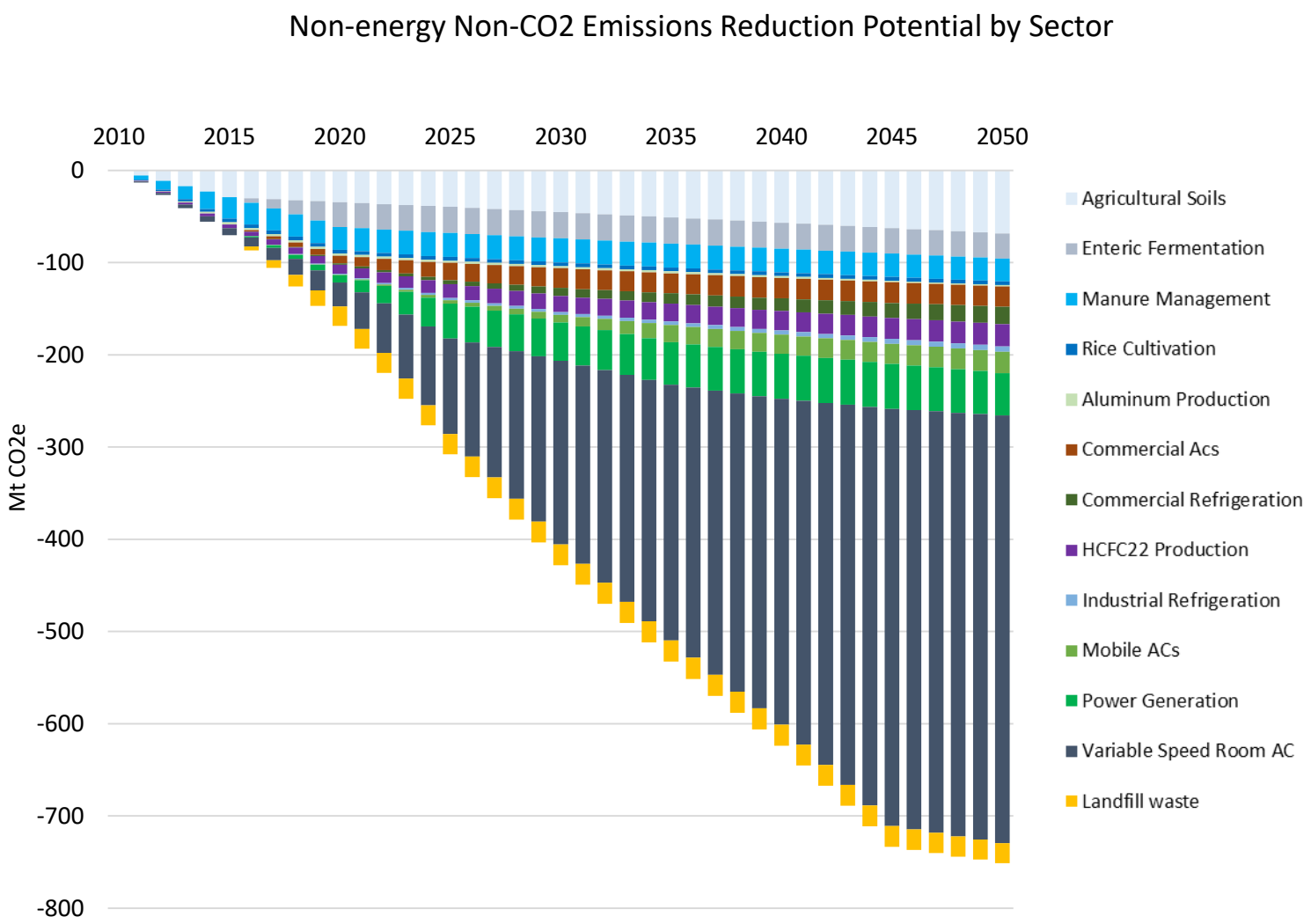
Largest non-energy mitigation potential is in HFC-125 and HFC-32, and methane



Mitigation Reduction % of Total Emissions

	2020	2030	2040	2050
Methane	-12%	-12%	-12%	-11%
Nitrous Oxide	-7%	-10%	-12%	-15%
HFC-23	-80%	-100%	-100%	-100%
HFC 32	-10%	-50%	-80%	-99%
HFC-134a	-13%	-33%	-43%	-44%
Sulphur hexafluoride	-14%	-58%	-58%	-58%
PFC116	-15%	-15%	-14%	-14%
HFC-125	-10%	-49%	-76%	-93%

Largest non-energy non-CO_2 mitigation reduction potential is in Room ACs



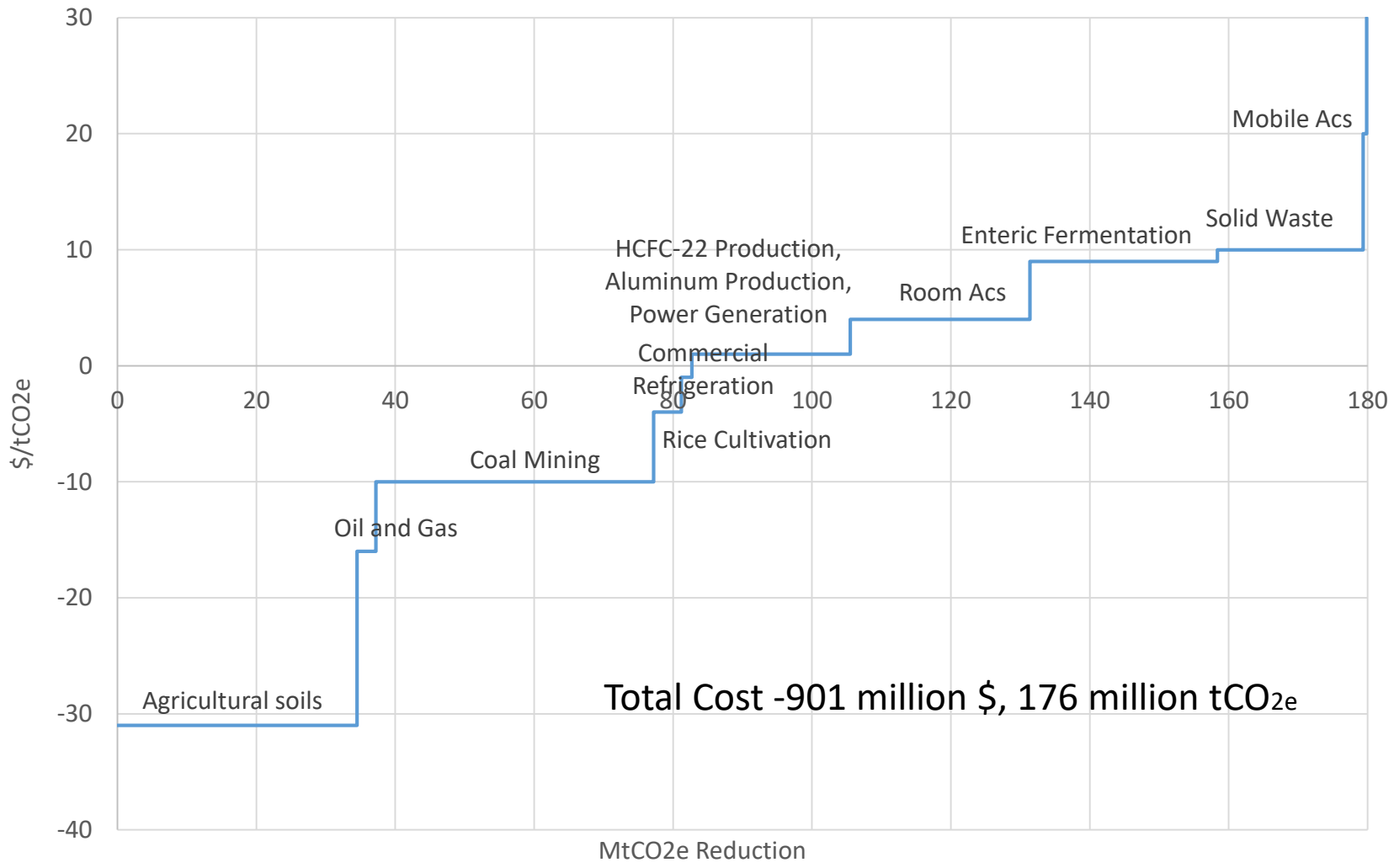
Mitigation Reduction % of Total Emissions

2020	2030	2040	2050
-13%	-17%	-22%	-27%
-10%	-10%	-10%	-10%
-24%	-24%	-24%	-24%
-3%	-3%	-3%	-3%
-15%	-15%	-15%	-15%
-15%	-30%	-30%	-30%
-11%	-33%	-33%	-34%
-80%	-100%	-100%	-100%
-21%	-43%	-43%	-43%
-4%	-44%	-89%	-89%
-14%	-58%	-58%	-58%
-10%	-50%	-80%	-100%
-35%	-35%	-35%	-35%

Cost Curve Development

- China cost curves for each sector were developed for 2020 and 2030, from the EPA report
- Key costs of our modeled reduction potential in 2020/2030 based on EPA mitigation cost estimates
  - Calculate reduction rate in 2020/2030 using our model results
  - Find the cost from EPA cost curve at the point where the same reduction rate is reached in 2020/2030
    - Find the cut-off cost
      - Calculate average cost using EPA cost curve at and below this cut-off cost

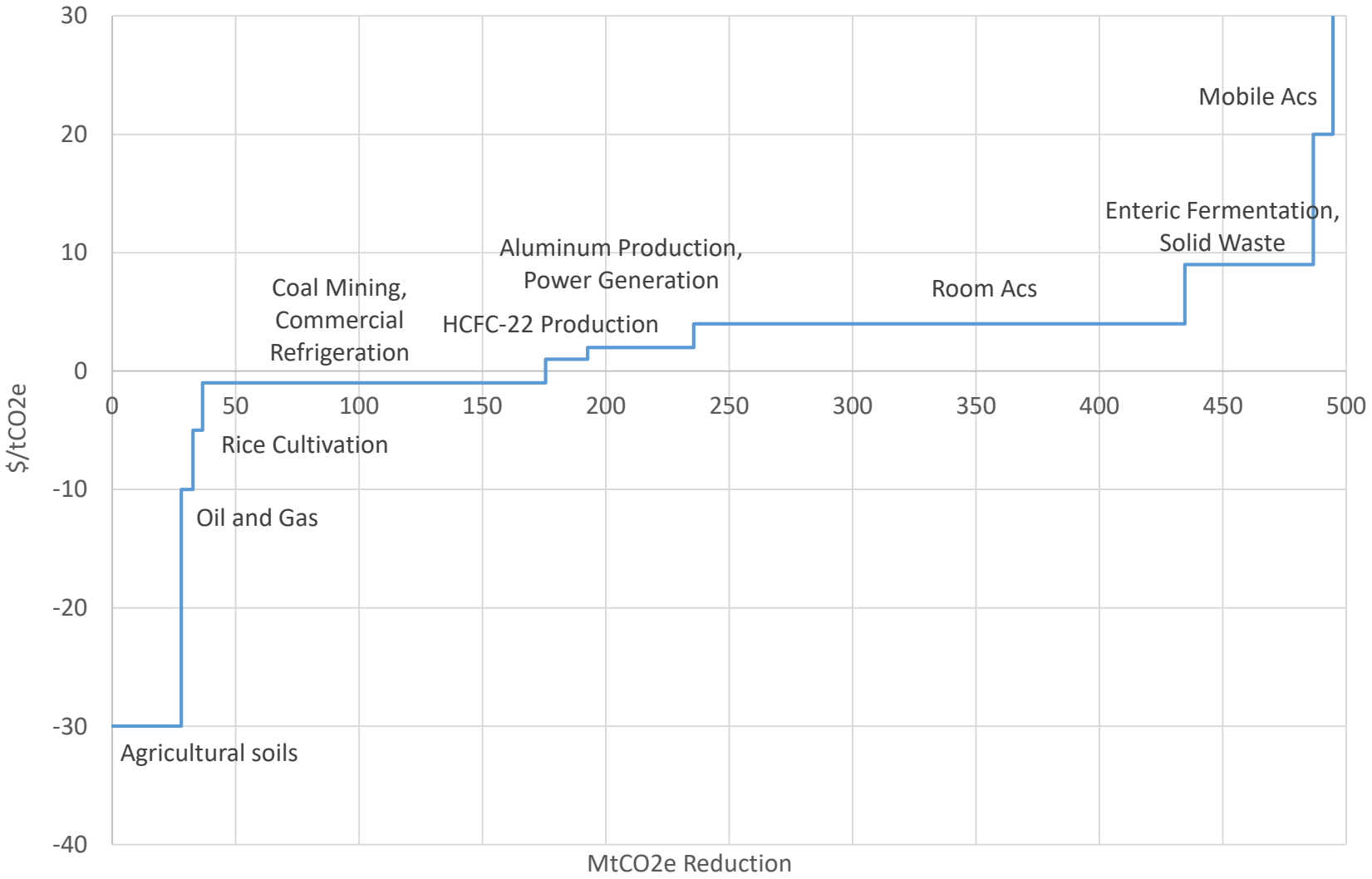
Cost curve by sector in 2020



In 2020, all mitigation potential in the sectors we considered in the model can be achieved at costs of below 20 $/tCO2e, except:

1) commercial ACs (8 MtCO2e) and industrial refrigeration (1 MtCO2e) are not considered because of lack of data;
2) manure management is not considered (about 25 MtCO2e reduction) because of lack of data;

Cost curve by sector in 2030, average cost less than 1 $/tCO2e



In 2030, all mitigation potential in the sectors we considered in the model can still be achieved at costs below 20 $/$tCO_{2e}$, except for commercial ACs and manure management because of lack of cost data.

Total Cost 481 million $, 495 million tCO_{2e}

Conclusions and Policy Implications

- A 40% mitigation potential with costs below 20 $/t$CO_{2e}$ for non-CO_2 GHGs by 2050.
- Largest potential: the industrial sector
  - a well-established policy framework: Montreal Protocol and the Kigali Amendment
  - Co-control or complementary policies
- Methane in coal mining and waste sector
  - Involves participation from diverse stakeholders and large numbers of companies
  - Policies evolve from voluntary practices to regulated standards
  - China to develop pilots

Conclusions and Policy Implications

- Methane and N_2O in the agricultural sector
  - Highly decentralized
  - Require the participation of millions of farmers
  - Consider yields and material inputs.
  - Need robust institutional mechanisms to disseminate cost-effective mitigation options while promoting behavioral changes to traditional farming practices.
  - Limited international experiences
  - Need more research
- Significant uncertainties due to lack of local data.
  - Consultation workshop planned for late summer/early fall to engage industrial partners.

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Thank You!

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