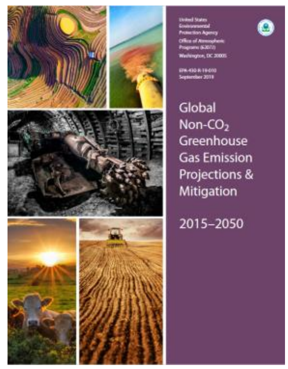
Global Non-CO_2 Greenhouse Gas Emission Projections & Mitigation 2015-2050



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EPA Non-CO_2 GHG Background

- EPA has implemented and runs a variety of non-CO_2 GHG voluntary programs
  - Coalbed Methane Outreach Program (CMOP)
  - The AgSTAR Program
  - Landfill Methane Outreach Program (LMOP)
  - Natural Gas STAR
  - SF_6 Emission Reduction Partnership for Electric Power Systems
  - GreenChill
- Through these programs EPA has collected highly detailed data about non-CO_2 GHG mitigation practices from partners
- Leveraging this data and other publicly available data EPA has developed a series of reports estimating emissions projections and mitigation potential from non-CO_2 GHG sources
- Baseline projections and estimates of mitigation are widely used in U.S. and global models that evaluate cost and availability of climate mitigation

Non-CO_2 GHG Analysis History

- 1999 & 2001
  - Reports on CH_4 and N_2O domestic mitigation potential
- 2005
  - Report on non-CO_2 GHG projections
- 2006
  - Stanford Energy Modeling Forum (EMF) 21 Study
- 2006
  - Global Mitigation of Non-CO_2 Greenhouse Gases
- 2012
  - Update to report on non-CO_2 GHG projections
- 2013
  - Update to Global Mitigation of Non-CO_2 Greenhouse Gases
- 2019 Combined Report on global projections and mitigation

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2019 Non-CO_2 Report Background

- Non-CO_2 GHG Report Goal:
  - Provide improved data to better understand the costs and opportunities for reducing non-CO_2 greenhouse gas emissions
  - Non-CO_2 GHG data is a primary input to models used for climate analyses
- 2019 Combined Report on global non-CO_2 GHG projections and mitigation
  - Previously separate reports, now consolidated in one publication
  - Based on standalone peer reviewed methodology document

Report Characteristics	
Projections	**Mitigation**
2015 to 2050, focus 2030	
20 sources, 200 countries	
Country-reported and calculated data to fill gaps	Global country estimates & U.S. state estimates
Business-as-usual (not modeling current policy)	Not a policy/market barrier analysis - Technical emissions reduction potential
Mitigation included from historical data	Known mitigation options and technological change (e.g. cost reductions through learning and deployment)

Sector/Source	CH_4	N_2O	HFCs	PFCs	SF_6	NF_3
Energy						
Natural gas and oil systems	•					
Coal mining activities	•					
Stationary and mobile combustion	•	•				
Biomass combustion	•	•				
Industrial Processes						
Adipic acid and nitric acid production		•				
Use of substitutes for ozone-depleting substances[a]			•			
HCFC-22 production			•			
Electric power systems					•	
Metals						
Primary aluminum production				•		
Magnesium manufacturing					•	
Electronics manufacturing			•	•	•	•
Agriculture						
Agricultural soils		•				
Livestock						
Enteric fermentation	•					
Manure management	•					
Rice cultivation	•	•				
Waste						
Landfilling of solid waste	•					
Wastewater	•	•				

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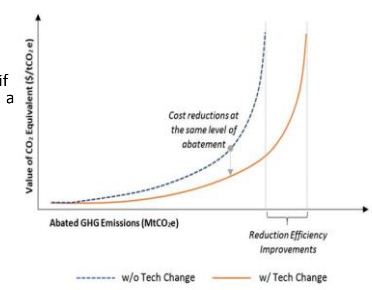
Methods: Projected Baseline

- Analysis employs two methods for generating projections:
  1. Composite of historical country-reported emissions and calculated estimates
     - Tier 1 calculated emission estimates were used to determine trends through the time series, but the emission factors, i.e., emissions per unit of activity data, derive primarily from country-reported information.
  2. Calculated estimates based on IPCC default emission factors and globally available activity data
     - Used only in absence of country-reported data.
- Projections represent a business-as-usual scenario
  - Includes current policies and measures to the extent that they are accounted for in the UNFCCC nationally-prepared GHG reports that EPA collected.
  - Mitigation options described by the MACCs reduce emissions from the baseline projections described here.
- Agriculture sector baseline emissions used to calculate mitigation amounts were based on biophysical crop model simulations combined with projected crop areas and livestock population data from the International Food Policy Research Institute International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) model.

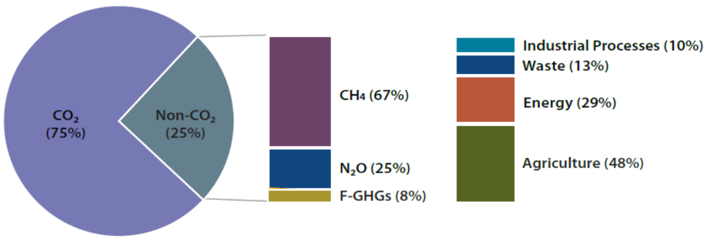
Methods: Mitigation Assessments

- General Methodology
  - Bottom-up engineering cost analysis.
  - Mitigation options and associated data is compiled from previous reports, sector-specific literature, and US EPA GHG voluntary program partner reported data.
  - MAC curves constructed for each region and sector by estimating the carbon price at which the present-value of benefits and costs for each mitigation option equilibrate.
  - Each point reflects the average price and reduction potential if a mitigation technology were applied across the sector within a given region.
- General Updates
  - Cost factors
  - Drivers (e.g. energy prices, labor, etc.)
  - Mitigation technologies for all sources
- MAC model improvements
  - Extended temporal scale through 2050
  - Technological change
    - Learning curve implemented to adjust costs over time
    - Increasing technological mitigation potential over time
  - Regionalized sectoral MAC curves for the United States



Non-CO_2 GHG Emissions – Context

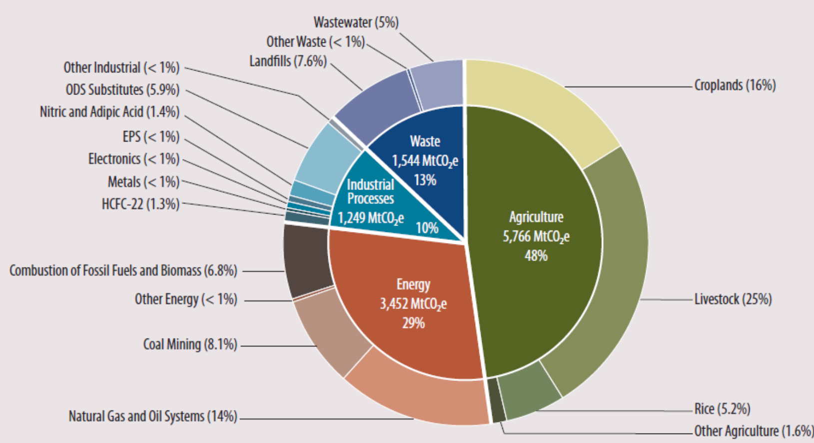
Global Non-CO_2 Emission by Gas and Sector in 2015
(Non-CO_2 GHGs = 12,010 $MtCO_2e$)



- Non-CO_2 GHG emissions comprised 25% percent of total GHG emissions in 2015
- CO_2 accounts for a large portion of annual GHG emissions, but non-CO_2 GHGs will play a significant role in future emissions scenarios
- CH_4 from agriculture, energy, and waste accounts for two-thirds of non-CO_2 GHG emissions

Non-CO_2 GHG Emissions – Context

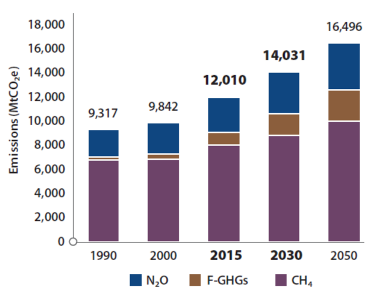
Global Non-CO_2 Emissions by Sector and Source, 2015



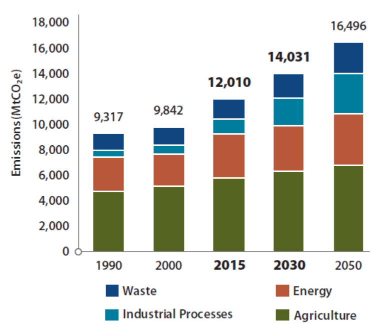
Non-CO_2 GHG Projections – Report Findings

- Historic global non-CO_2 emissions levels rose by about 29% (1990 to 2015).
- Between 2015 and 2030, global non-CO_2 emissions are estimated to continue to increase by approximately 17% under a business-as-usual scenario (i.e. continuation of current practices, not modeling specific policies or goals).
  - F-GHG emissions projected to increase 86%
  - **CH_4 emissions projected to increase 9%**
  - N_2O emissions projected to increase 14%
- Waste and industrial processes sectors are projected to grow at the fastest rates between 2015 and 2030, 23% and 76%, respectively.

Global Non-CO_2 Emissions by Gas ($MtCO_2e$)



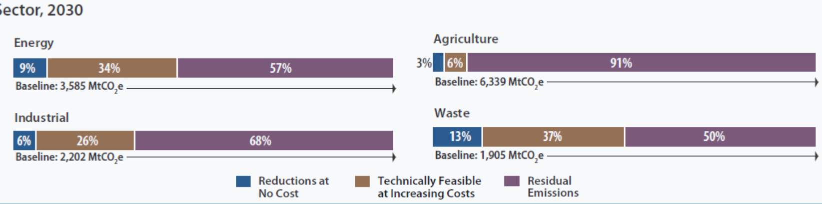
Global Non-CO_2 Emissions, by Sector ($MtCO_2e$)



Non-CO_2 GHG Mitigation – Report Findings

- 2030 total technical mitigation potential by sector:
  - Energy sector – 1,551 $MtCO_2e$ (43% of BAU emissions)
  - Waste sector – 957 $MtCO_2e$ (50% of BAU emissions)
  - Industrial processes sector – 705 $MtCO_2e$ (32% of BAU emissions)
  - Agriculture sector – 681 $MtCO_2e$ (10% of BAU emissions)

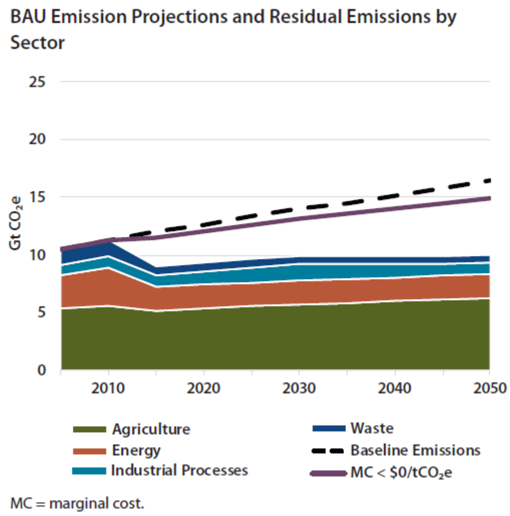
Mitigation Potential and Residual Emissions by Sector, 2030



- The total technical mitigation potential for CH_4 is 34% of BAU emissions

Non-CO_2 GHG Mitigation – Report Findings

- Over 1,300 $MtCO_2e$ available at \$0/tCO_2e in 2030
- Maximum technical potential in 2030 is nearly 4,000 $MtCO_2e$, ~34% of projected non-CO2 GHG emissions that year.
  - 70% of total global mitigation potential comes from CH_4 sources
- Waste sector (landfills) is the largest source of mitigation potential in 2030
- Non-CO_2 GHG emissions can be held roughly constant by deploying available mitigation technologies.
  - Remaining “residual” emissions after mitigation options are implemented.
- Achieving long-term reductions of non-CO_2 GHG emissions below the 2015 level would require deployment of new or more effective mitigation technologies.



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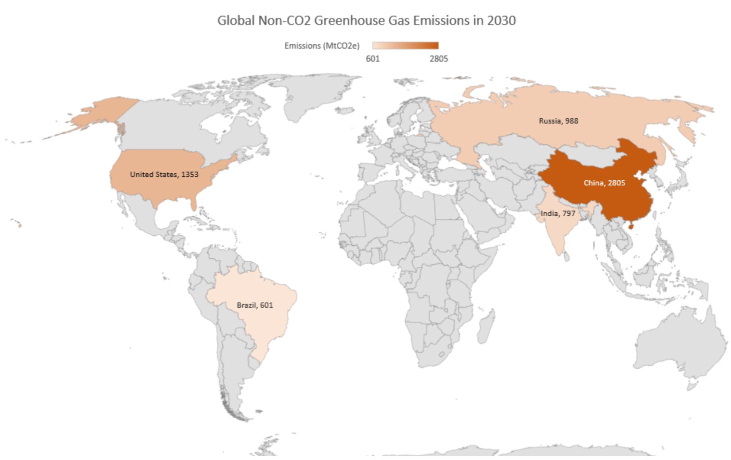
Report Findings – Country Level Emissions Projections

- Under BAU scenario (i.e. continuation of current practices and policies), top emitting countries in 2030: China, United States, Russia, India, Brazil



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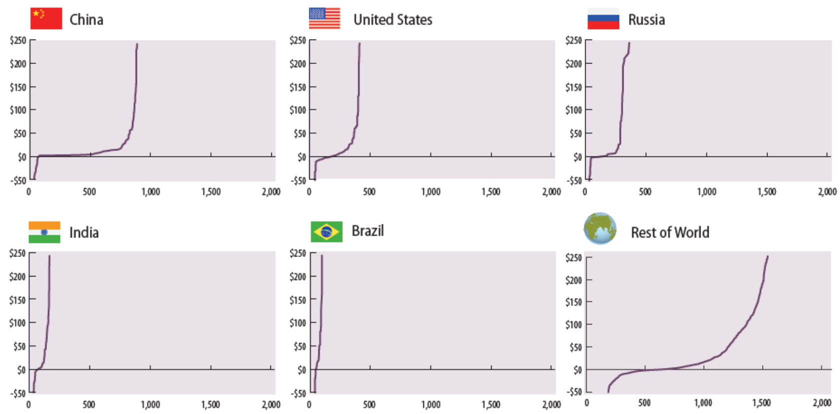
Report Findings – Country Level Mitigation Detail

Marginal Abatement Cost Curves, 2030



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Conclusions

- Greater understanding of non-CO_2 mitigation potential and associated costs is important for:
  - Understanding policy trade-offs
  - Designing efficient and plausible climate mitigation strategies
  - Targeting future mitigation technology development and deployment
  - Understanding the limits of mitigation technologies and targeting areas for behavioral change
- The inclusion of technical change results in more mitigation overall and a greater volume available at lower costs
  - While tech change results in more mitigation, there is a large portion of baseline emissions that remain as residual
- Non-CO_2 GHG emissions can be held roughly constant by deploying available mitigation technologies.
- Achieving long-term reductions of non-CO_2 GHG emissions below the 2015 level would require deployment of new or more effective mitigation technologies.

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Contact Information

- This report is available for download on the U.S. EPA's homepage at https://www.epa.gov/global-mitigation-non-co2-greenhouse-gases
- The data is also accessible through a data exploration tool at https://cfpub.epa.gov/ghgdata/nonco2/
- For more information contact:

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