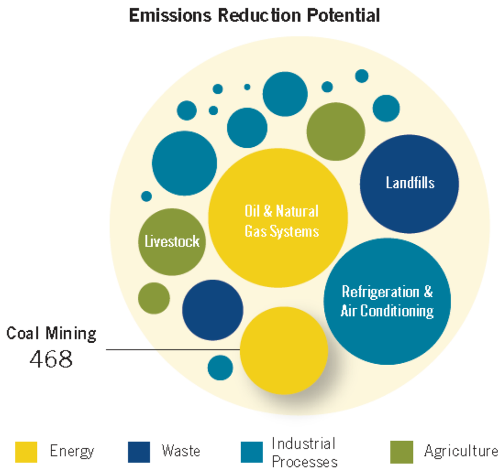
# Global Mitigation of Non-$CO_2$ Greenhouse Gases: 2010 - 2030



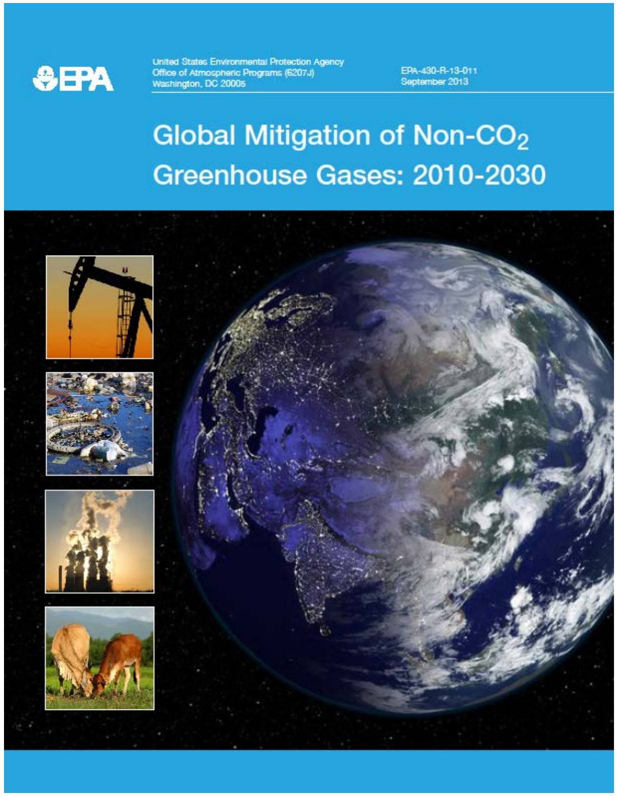


Shaun Ragnauth – U.S. EPA


International Energy Workshop, 2015
Abu Dhabi, UAE

# Non-$CO_2$ Global Mitigation Report: 2010-2030 Background

- USEPA has developed a comprehensive global mitigation analysis for non-$CO_2$ GHGs, covering:
  - All non-$CO_2$ greenhouse gases (methane, nitrous oxide, high GWP gases)
  - All emitting sectors (energy, waste, agriculture, and industrial processes)
    - Coal mining ($CH_4$)
    - Oil and natural gas systems ($CH_4$)
    - Solid waste management ($CH_4$)
    - Wastewater ($CH_4$, $N_2O$)
    - Specialized industrial processes ($N_2O$, PFCs, $SF_6$, HFCs)
    - Agriculture ($CH_4$, $N_2O$).
  - Global coverage – disaggregated at the country level
  - 2010 – 2030
- Coupled with baseline emission projections from EPA's non-$CO_2$ projections report
- Has undergone an external peer review process
- Builds on work started in 1999
  - 2001 & 1999 EPA reports on $CH_4$ and $N_2O$ domestic mitigation potential
  - Stanford Energy Modeling Forum – EMF-21
  - 2006 Global Mitigation of Non-$CO_2$ Greenhouse Gases
- Provides improved data to better understand the costs and opportunities for reducing non-$CO_2$ greenhouse gas emissions.




***Global Mitigation of Non-$CO_2$ Greenhouse Gases***
**(USEPA, 2013)**

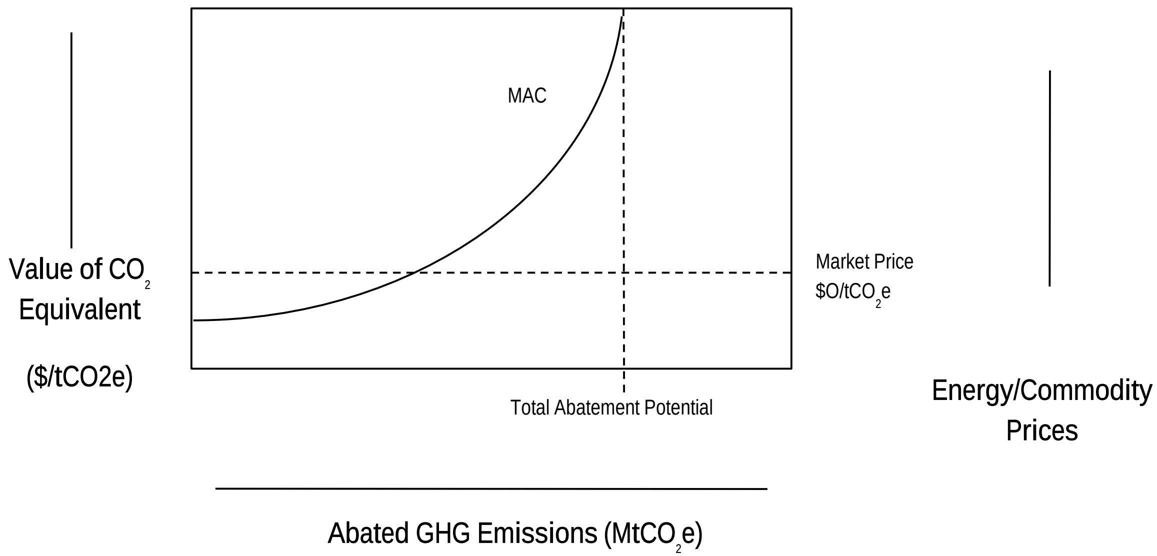
# Data Sources and Models

- Data sources
  - Emissions baseline:
    - Domestic - U.S. Inventory of Greenhouse Gases and Sinks
    - International regions - Global Anthropogenic Non-CO2 Greenhouse Gas Emissions: 1990-2030
  - Emissions projections:
    - Global Anthropogenic Non-CO2 Greenhouse Gas Emissions: 1990-2030 (EPA 430-D-11-003)
    - Sector specific models for agriculture sources
      - DayCent (croplands)
      - IMPACT (livestock)
      - DNDC (rice)
  - Labor, energy and commodity prices:
    - Labor - U.S. BLS
    - Energy - EIA – AEO 2010, International Energy Statistics
    - Materials – UNCTAD Statistical Database
  - Mitigation and cost estimates:
    - Sector specific engineering and cost studies
    - Industry reported and supplied data
    - U.S. EPA Clean Watersheds Needs Survey
- Models
  - MAC model (EPA)
    - GAMS based model allows for fast updates to MACs based on new projections, cost, mitigation data, or other updated parameters
  - DNDC Model (Applied Geosolutions/UNH)
    - Rice mitigation
  - DayCent Model (University of Colorado)
    - Croplands
  - IMPACT Model (IFPRI)
  - Vintaging Model (EPA)

# Methodology

MACs provide information on the amount and cost of emissions reductions that can be achieved in a given sector

- Abatement options are represented through bottom-up engineering cost analysis
- Costs, benefits, and potential mitigation is assessed for each option
- For each sector and region the MAC curve is determined by the series of breakeven price calculations for the suite of available options
- Each point reflects the average price and reduction potential for a given abatement option



# Methodology Continued – Abatement Options

- Abatement option emission reduction

  Technical Effectiveness * Baseline Emissions = Emission Reduction

  - Technical effectiveness determined by
    - Technical applicability
      - Portion of sector wide baseline option is applicable to
    - Market share
      - Avoids double counting of competing options
    - Reduction efficiency
      - Technically achievable abatement from an option

| Technical Applicability (%) | X | Market Share[a] (%) | X | Reduction Efficiency (%) | = | Technical Effectiveness (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Technical Effectiveness (%) | X | Baseline Unit Emissions ($MtCO_2e$) | = | Unit Emission Reduction ($MtCO_2e$) |
| Percentage of total baseline emissions from a particular emissions source to which a given option can be potentially applied. | | Percentage of technically applicable baseline emissions to which a given option is applied; avoids double counting among competing options | | Percentage of technically achievable emissions abatement for an option after it is applied to a given emissions stream | | Percentage of baseline emissions that can be reduced at the national or regional level by a given option. | | Emissions stream to which the option is applied | | Unit emission reductions |

# Example Mitigation Options Modeled

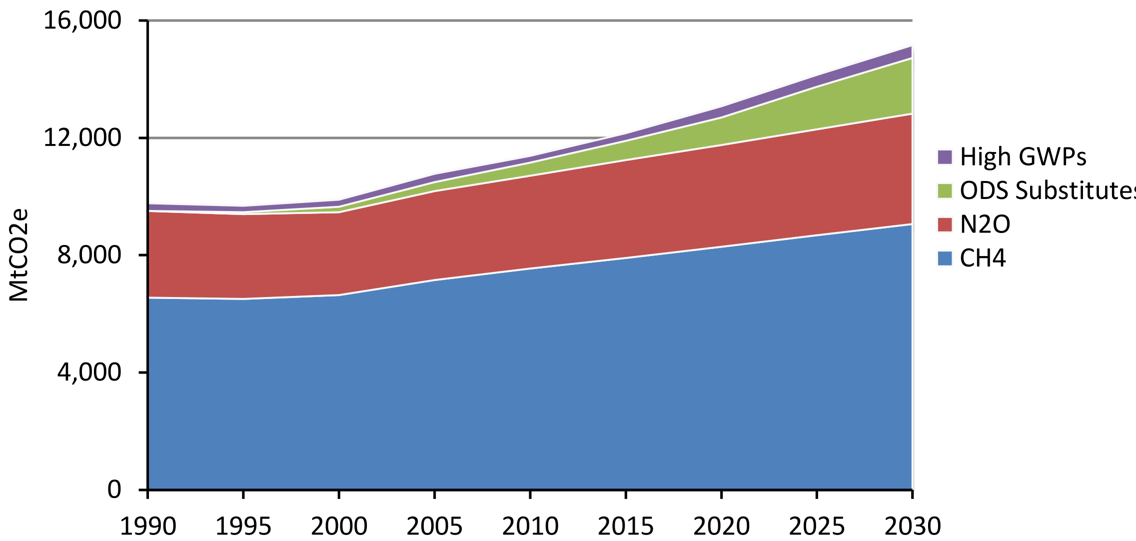
Table C-1: Example Break-Even Prices for Natural Gas and Oil System Technology Options in 2010

| Abatement Measure | System Component/ Process | Reduced Emissions ($tCO_2e$) | Annualized Capital Costs ($/$tCO_2e$) | Annual Cost ($/$tCO_2e$) | Annual Revenue ($/$tCO_2e$) | Tax Benefit of Depreciation ($/$tCO_2e$) | Break-Even Price ($/$tCO_2e$) | Incremental Reduction ($MtCO_2e$) |
|---|---|---|---|---|---|---|---|---|
| Oil and Gas Production | | | | | | | | |
| Convert gas pneumatic controls to instrument air | Pneumatic device vents | 71.0 | $335.68 | $441.41 | $10.01 | $82.50 | $684.58 | 15.29 |
| Directed inspection & maintenance at gas production facilities | Chemical injection pumps | 15.2 | $0.00 | $440.34 | $10.01 | $0.00 | $430.33 | 0.44 |
| Directed inspection & maintenance at gas production facilities | Deepwater gas platforms | 6,687.0 | $0.00 | $7.48 | $10.01 | $0.00 | −$2.53 | 0.21 |
| Directed inspection & maintenance at gas production facilities | Non-associated gas wells | 2.8 | $0.00 | $289.00 | $10.01 | $0.00 | $279.00 | 0.97 |
| Directed inspection & maintenance at gas production facilities | Pipeline leaks | 5.0 | $0.00 | $16.44 | $10.01 | $0.00 | $6.43 | 1.78 |
| Directed inspection & maintenance at gas production facilities | Shallow water gas platforms | 1,584.6 | $0.00 | $21.04 | $10.01 | $0.00 | $11.03 | 2.57 |
| Flaring instead of venting on offshore oil platforms | Offshore platforms, shallow water oil, fugitive, vented and combusted | 7,929.0 | $4,584.45 | $627.65 | $10.01 | $929.86 | $4,272.24 | 8.94 |
| Install flash tank separators on dehydrators | Dehydrator vents | 18.1 | $402.90 | $0.00 | $10.01 | $122.18 | $270.71 | 0.75 |
| Installing catalytic converters on gas fueled engines and turbines | Gas engines - Exhaust vented | 36,389.4 | $0.06 | $0.12 | $0.00 | $0.01 | $0.16 | 2.55 |
| Installing electronic starters on production field compressors | Compressor starts | 2.7 | $266.82 | $2,172.15 | $10.01 | $65.58 | $2,363.39 | 0.07 |
| Installing plunger lift systems in gas wells | Non-associated gas wells | 2.4 | $1,042.59 | −$5,818.60 | $10.01 | $316.18 | −$5,102.19 | 0.82 |
| Installing plunger lift systems in gas wells | Well clean ups (LP Gas Wells) | 423.25 | $5.87 | −$32.73 | $10.01 | $1.78 | −$38.65 | 29.93 |
| Installing plunger lift systems in gas wells | Gas well workovers | 0.8 | $2,960.86 | −$16,524.21 | $10.01 | $897.92 | −$14,471.28 | 0.01 |
| Installing surge vessels for capturing blowdown vents | Compressor BD | 0.8 | $43,398.61 | $34,987.60 | $10.01 | $8,802.49 | $69,573.71 | 0.02 |
| Installing surge vessels for capturing blowdown vents | Vessel BD | 0.0 | $2,088,733.32 | $1,683,919.51 | $10.01 | $423,655.25 | $3,348,987.59 | 0.01 |

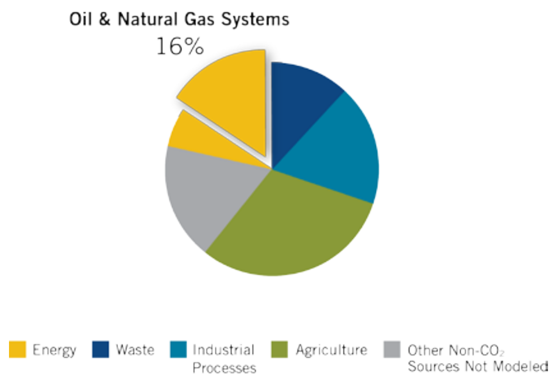
(continued)

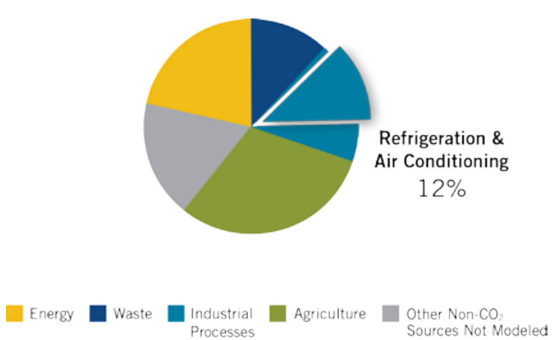
# Baseline and Projections

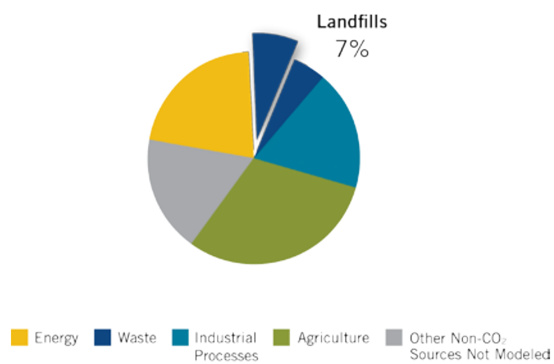
- Non-Ag sectors utilize USEPA 2012 global projections
- Ag sector projections are based on DNDC, DayCent, and IFPRI IMPACT
- 2030 projected non-CO2 GHG emissions is over 15 Gt
- Top emitting sectors in 2030:

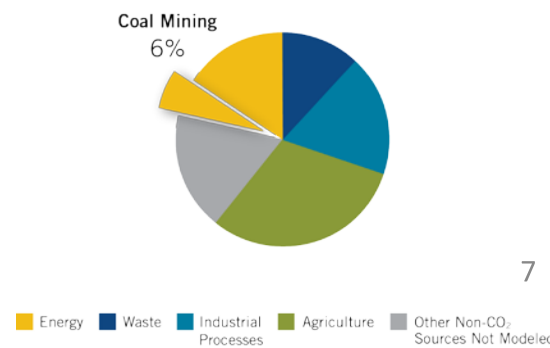



Source: *Global Anthropogenic Non-$CO_2$ Greenhouse Gas Emissions: 1990-2030. USEPA, 2012*



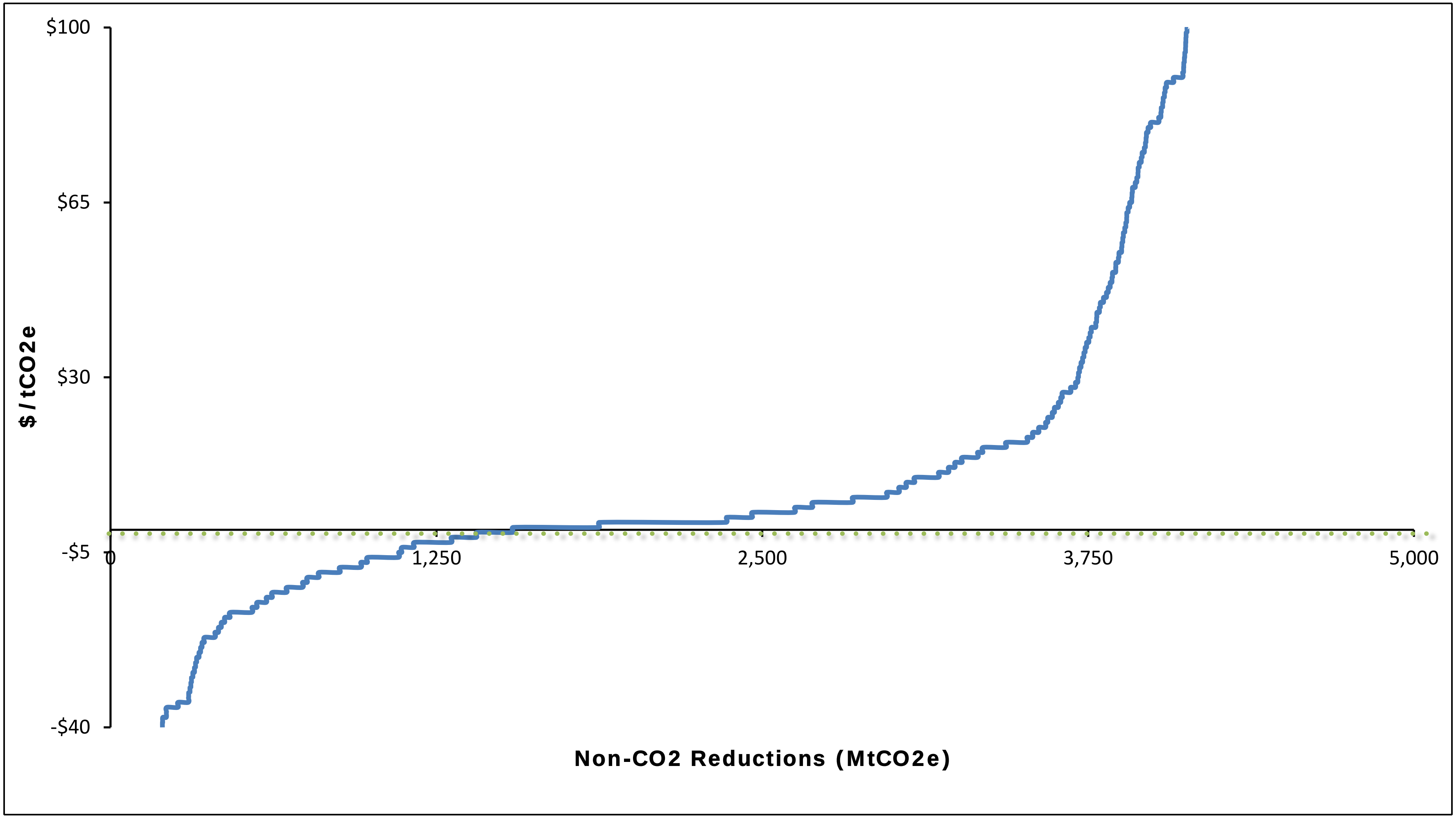



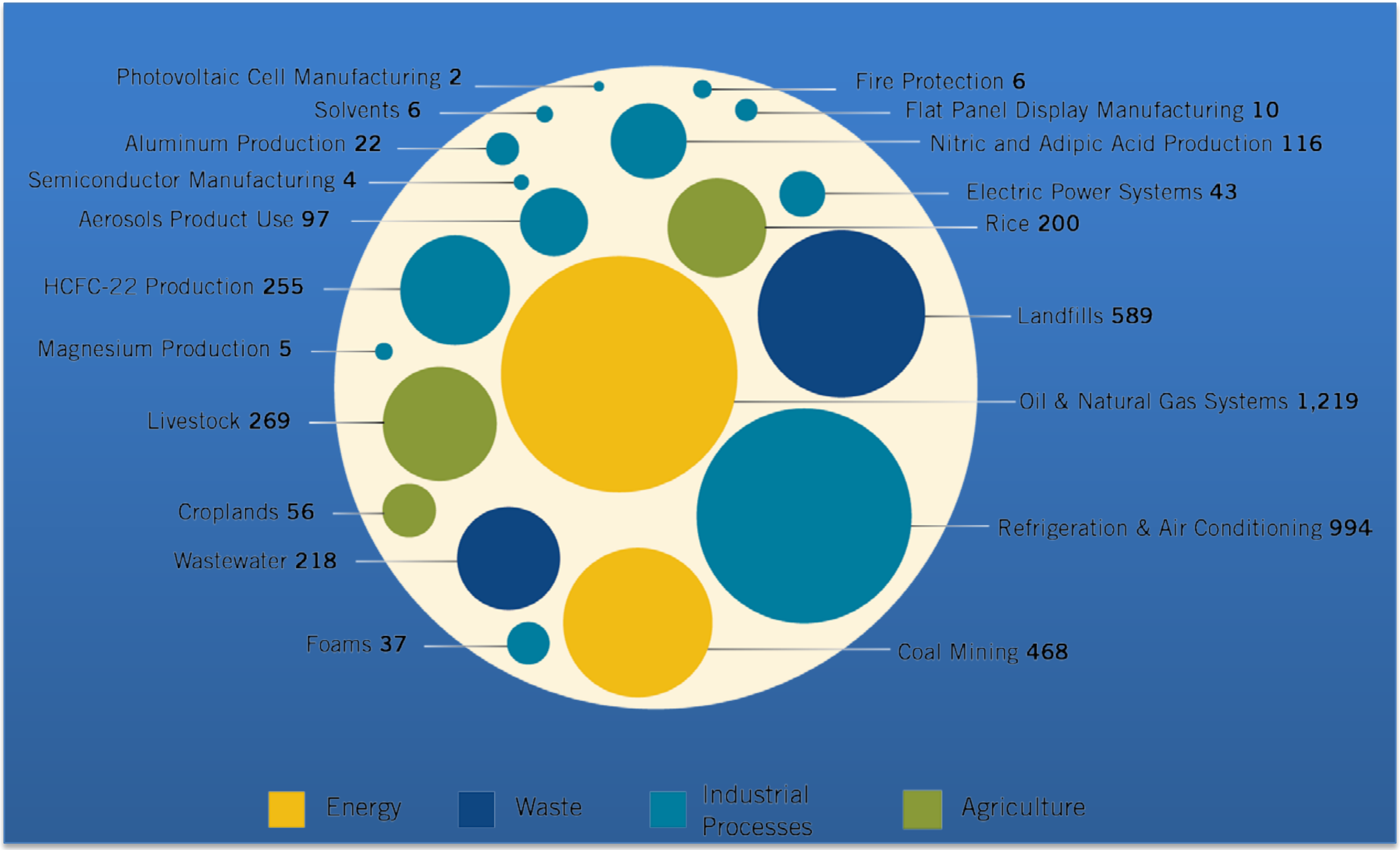
# Aggregate Results – Global MAC (2030)

**Worldwide cost-effective mitigation potential is 1,772 $MtCO_2e$ in 2030**



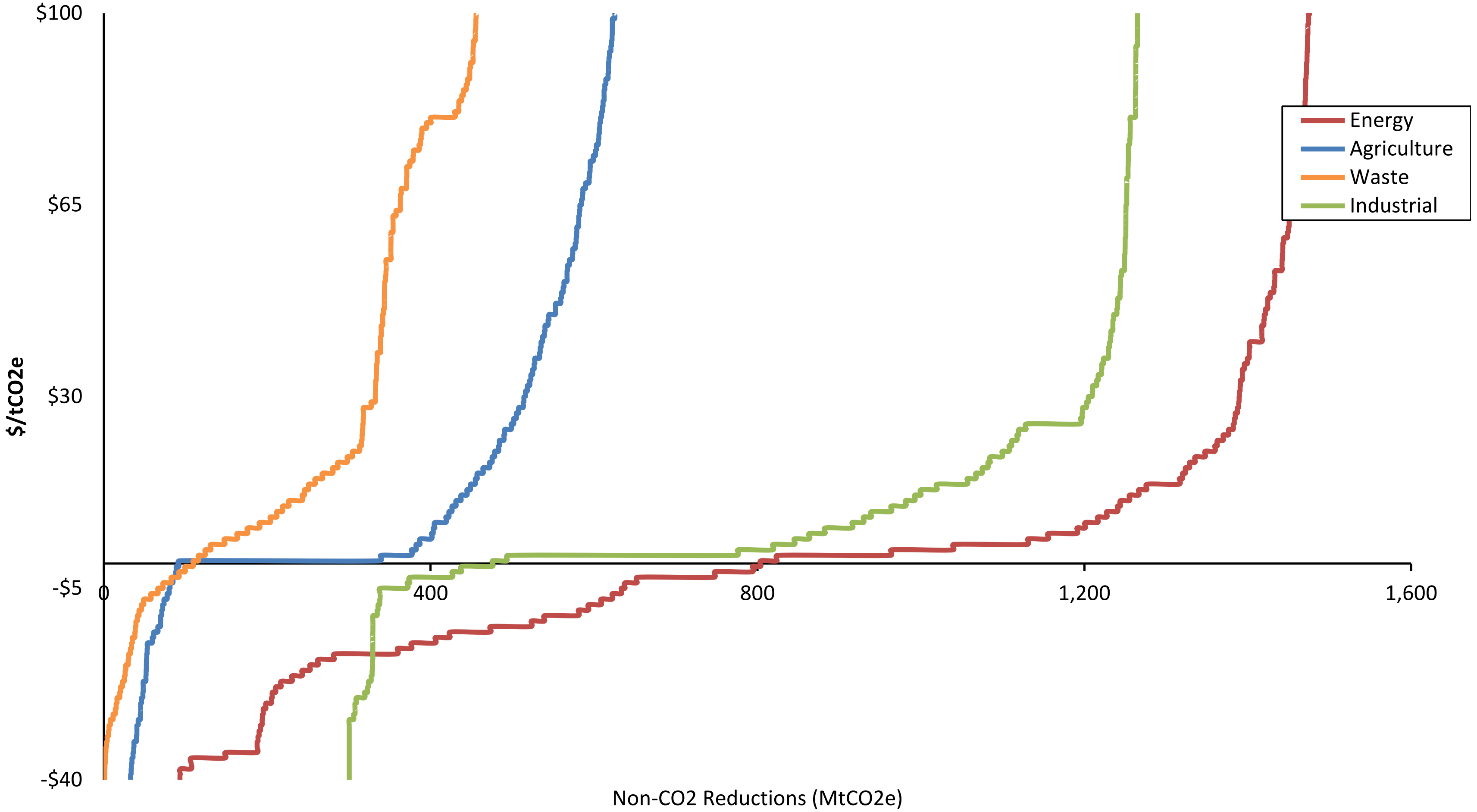
# Key Findings

- Total technically feasible global mitigation from non-$CO_2$ GHG sources in 2030 is over 3,500 $MtCO_2e$



# Aggregate Results – MACs by Sector (2030)

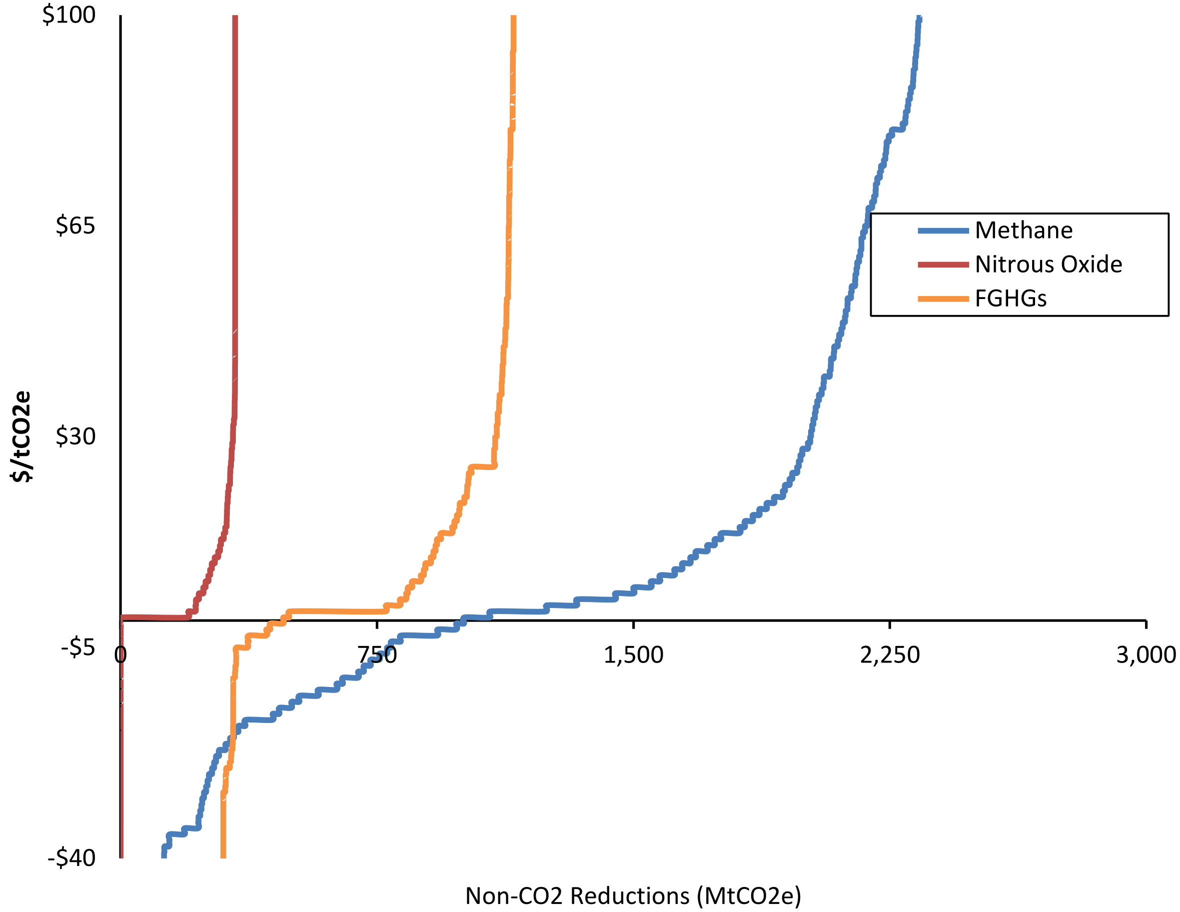
**Globally, the sectors with the greatest potential for mitigation of non-$CO_2$ greenhouse gases are the energy and industrial process sectors.**



# Aggregate Results – MACs by GHG (2030)

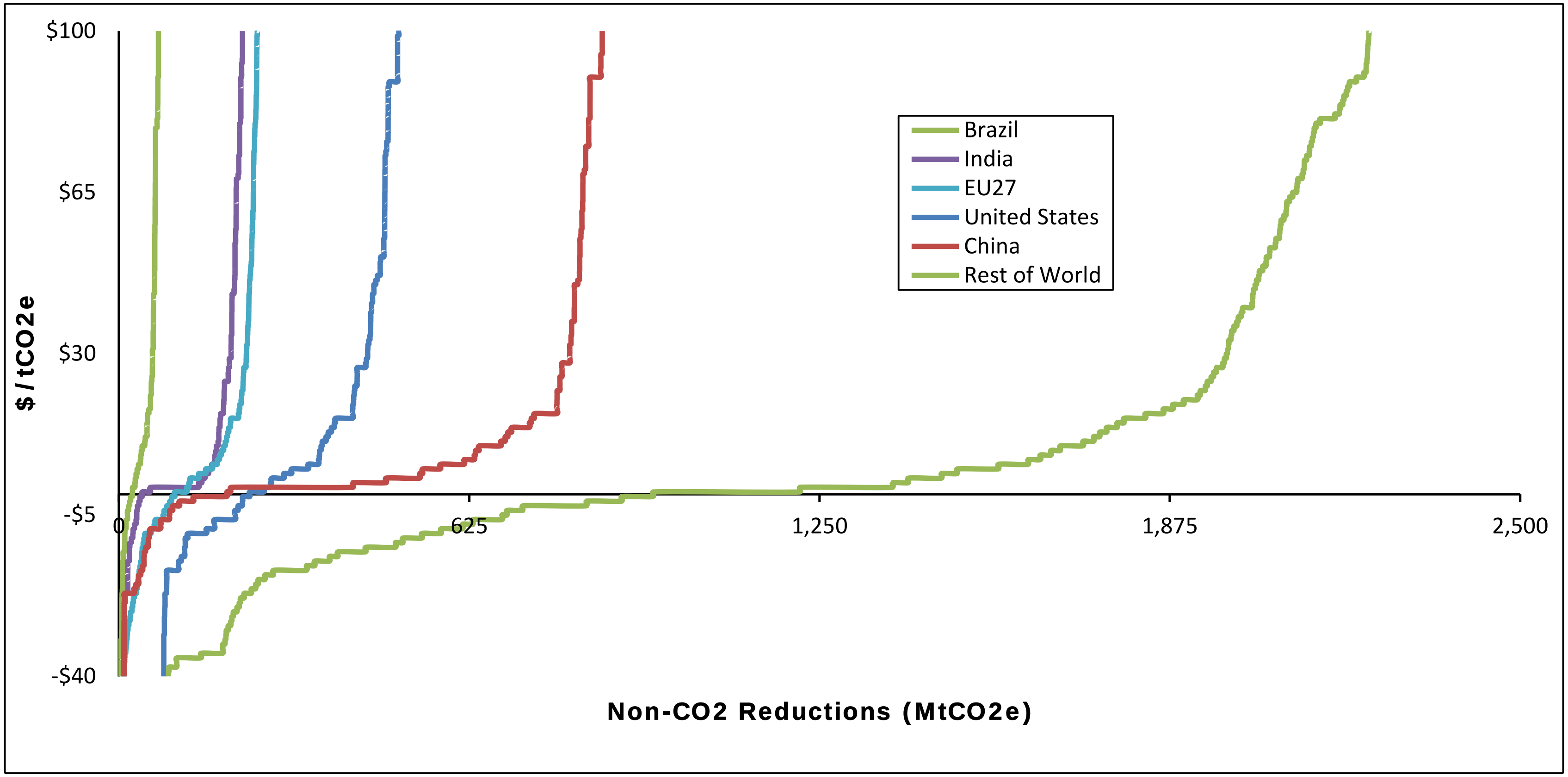
**Methane mitigation has the largest potential among non-$CO_2$ greenhouse gases.**

- At a cost-effective level, the potential for methane mitigation is greater than 1000 $MtCO_2eq$.
- The potential for reducing methane emissions grows two-fold as the breakeven price rises from $0 to $20/$tCO_2eq$.
- While less than that of methane, nitrous oxide and high-GWP gases exhibit significant cost-effective mitigation potential.



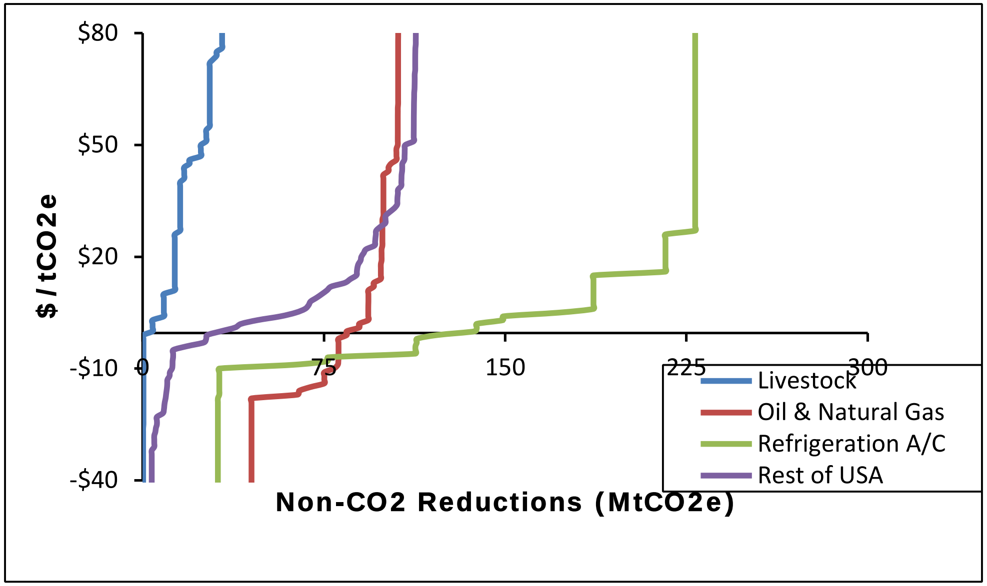
# Aggregate Results – MACs by Region (2030)

- China and the U.S. are the top two contributors to global mitigation potential with cost effective mitigation of 249 and 165 $MtCO_2e$ respectively.

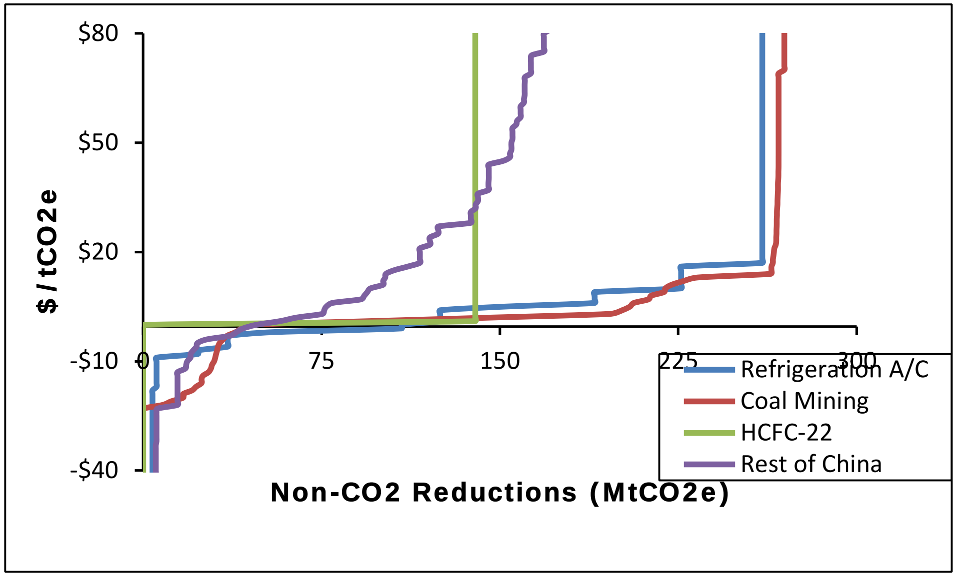


# MACs - U.S. and China

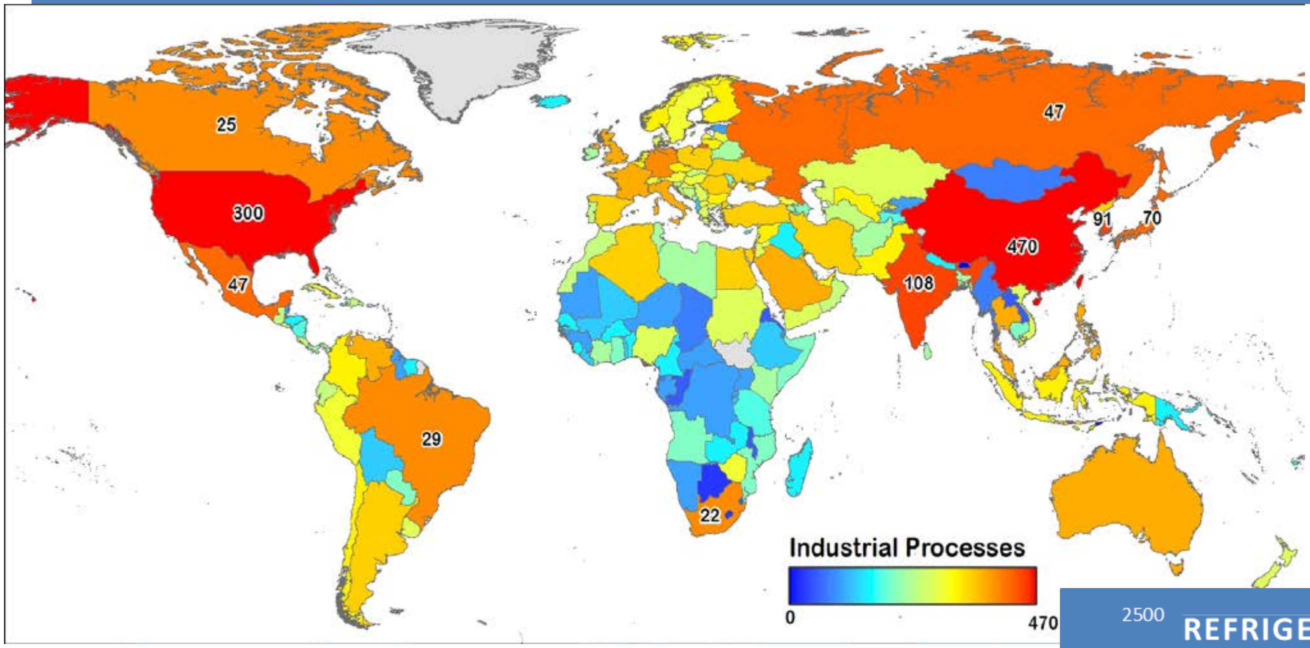
U.S. 2030 MAC



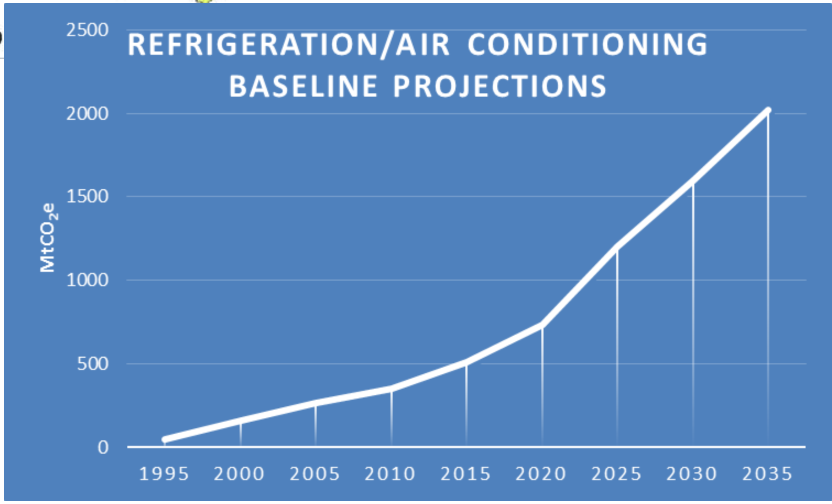

China 2030 MAC



# MACs by Sector - Industrial (2030)

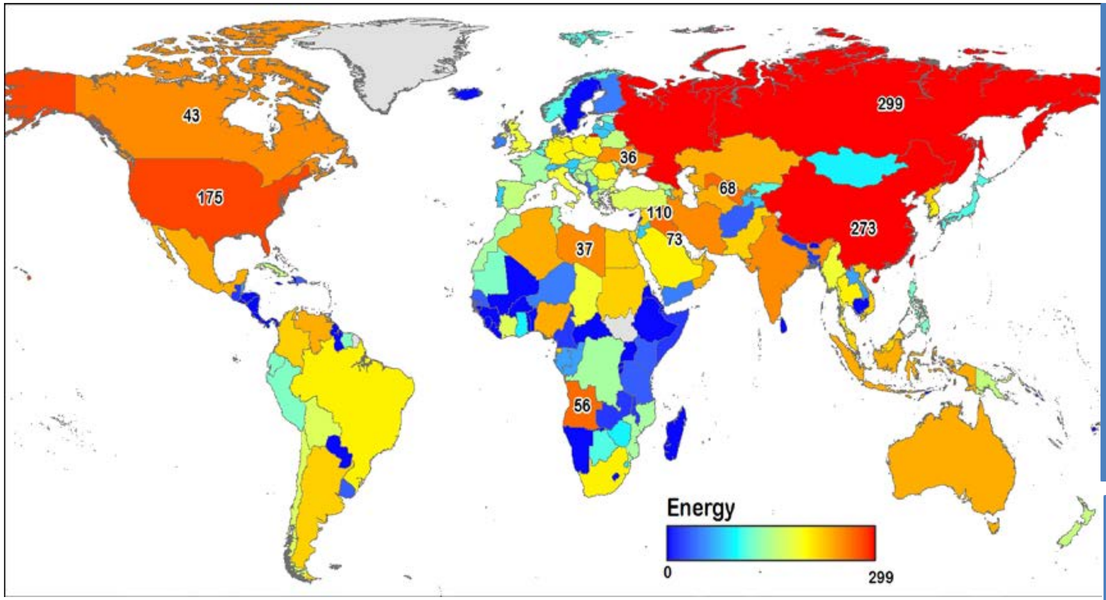


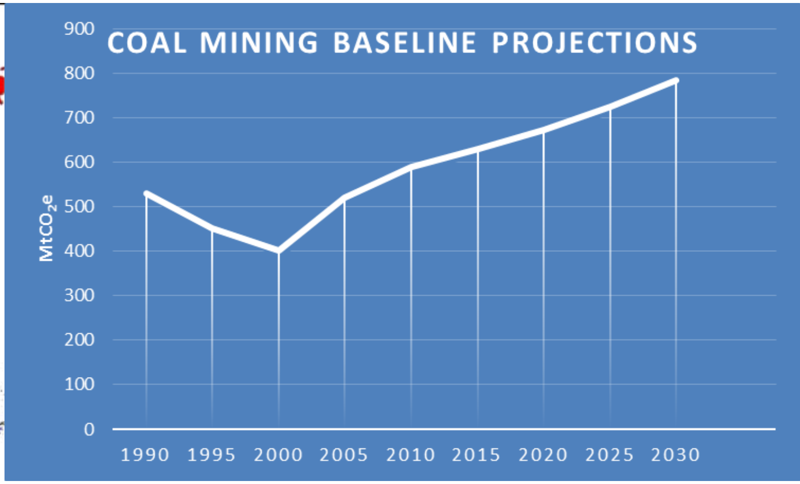

- Refrigeration/AC
  - Global emissions associated with Ref/AC projected to increase ~300% between 2015 and 2030
  - Mitigation potential
    - Model evaluates ~ 20 mitigation options
    - Maximum global mitigation potential in 2030 is ~ 1000 $MtCO_2e$, 82%
    - \$5/$tCO_2e$ global mitigation is over 600 $MtCO_2e$

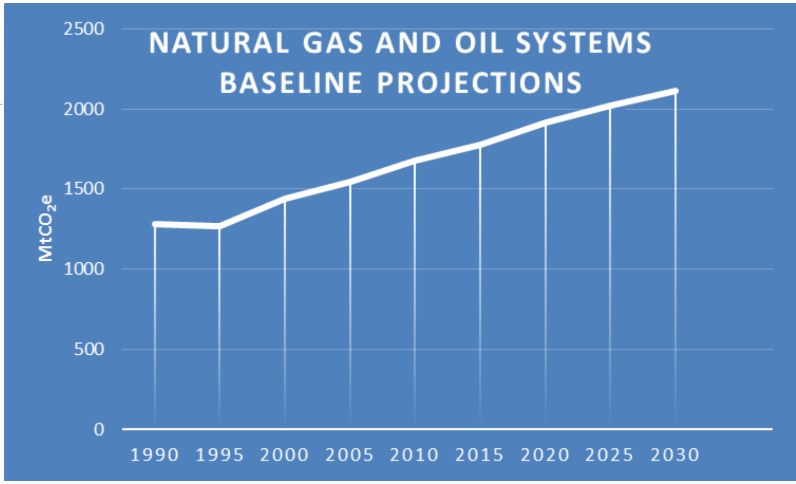



Source: Global Anthropogenic Non-$CO_2$ Greenhouse Gases: 1990-2030, USEPA 2012

# MACs by Sector - Energy (2030)



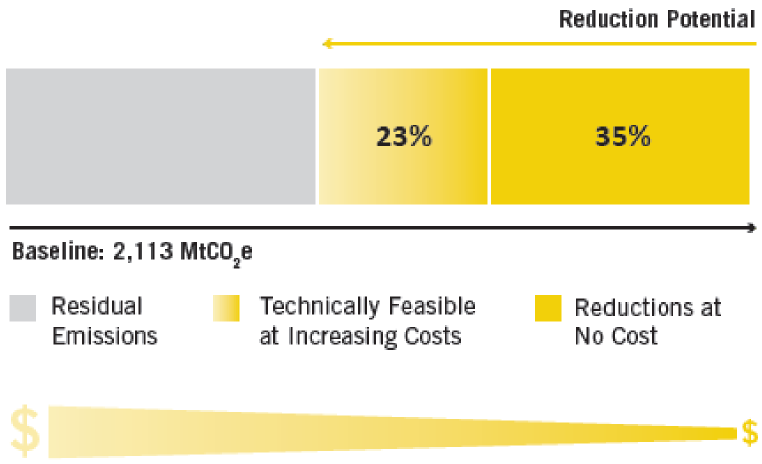



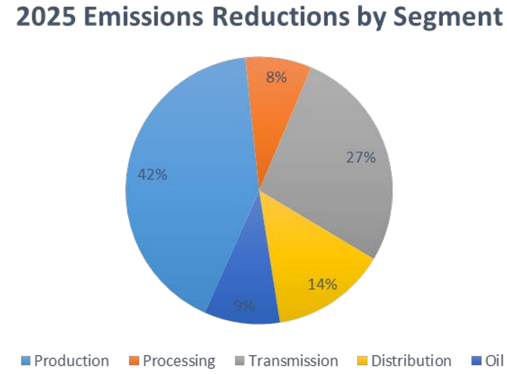




Source: Global Anthropogenic Non-$CO_2$ Greenhouse Gases: 1990-2030, USEPA 2012

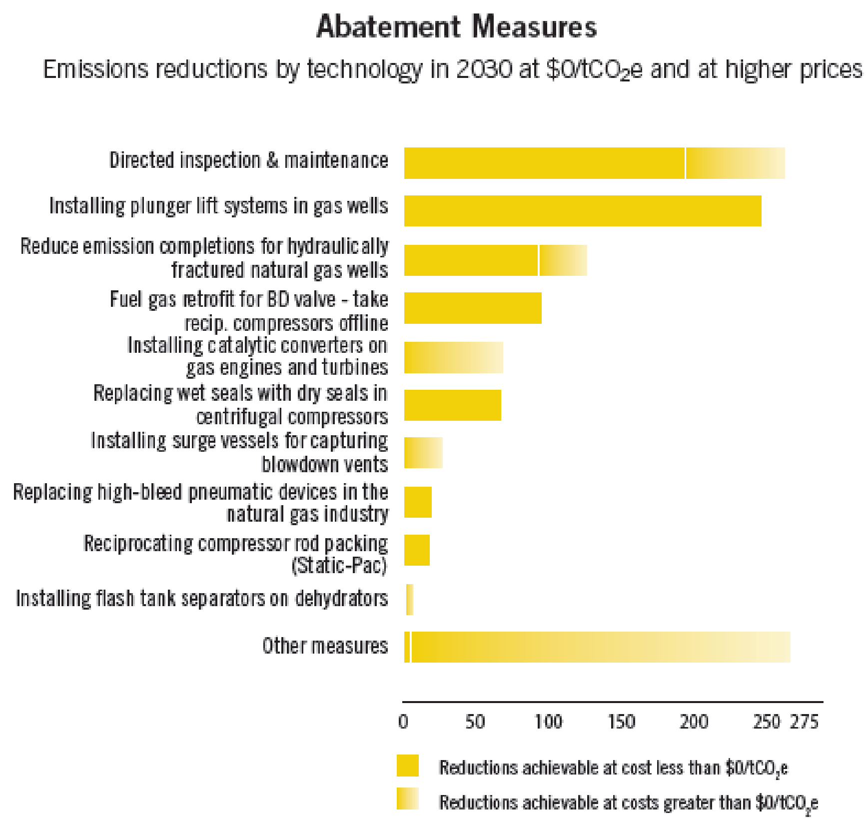
- Global emissions associated with natural gas and oil systems projected to increase ~19% (~335 $MtCO_2e$) between 2015 and 2030
- Global emissions associated with coal mining projected to increase 25% (154 $MtCO_2e$) between 2015 and 2030
- Total global technically feasible mitigation potential is over 1500 $MtCO_2e$

# Model Results – Oil and Gas (2030)




- Model outputs abatement potential disaggregated by segment and mitigation option
- Mitigation potential
  - Model evaluates over 100 mitigation options across four oil/gas segments
  - Maximum global mitigation potential in 2030 is over 1,200 MtCO2e, 58%
  - $5/tCO2e global mitigation is over 800 MtCO2e



# Prior Study Comparison

- Compared to EPA 2006 Non-$CO_2$ Mitigation Report, total aggregate abatement potential is 5% higher
  - Drivers include
    - Model updates
    - New sectors and abatement options
    - Updated inputs (energy prices, capital costs, O&M costs, etc.)

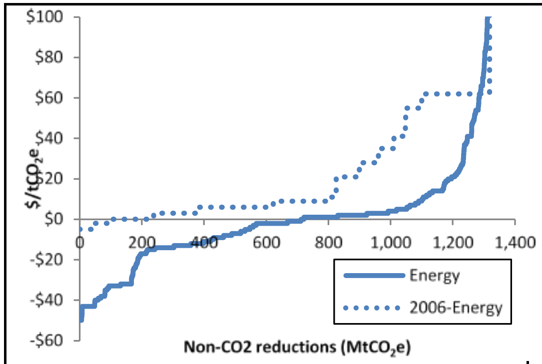



Figure 13a. Energy Sector MACs for 2020

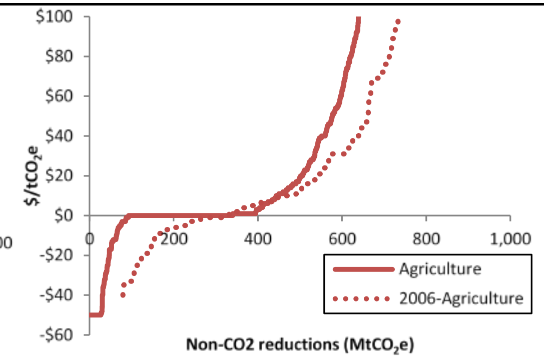



Figure 13b. Agricultural Sector MACs for 2020

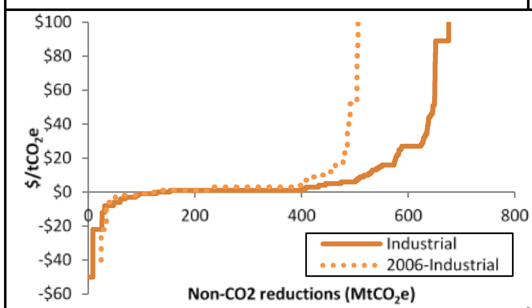



Figure 13c. Industrial Sector MACs for 2020

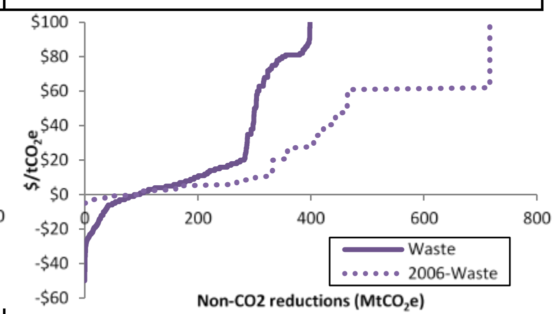


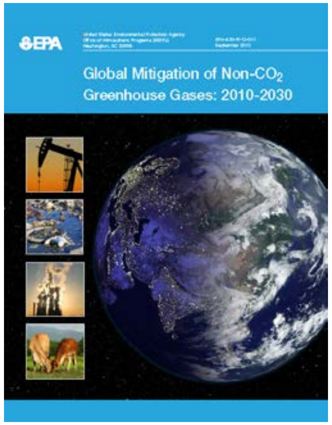

Figure 13d. Waste Sector MACs for 2020

# Summary

- Significant cost-effective mitigation exists from non-$CO_2$ sources with mitigation options that are available today
- Energy sector sources are a major source of relatively low cost abatement potential
- Despite potential for project level cost savings and environmental benefits, barriers to mitigating non-$CO_2$ emissions (particularly $CH_4$) continue to exist:
  - Traditional industry practices
  - Regulatory and legal issues
  - Uncertain investment climate
- Report and data set can feed in to a number of climate analytical needs
  - CGE modeling
  - Analysis of cost and availability of mitigation opportunities
  - Climate policy analysis

# More Information

- Mitigation Report available on the web at:




http://www.epa.gov/climatechange/EPAactivities/economics/nonco2mitigation.html

- Projections Report available on the web at:

http://www.epa.gov/climatechange/EPAactivities/economics/nonco2projections.html

- Contact:

Shaun Ragnauth
US EPA – Climate Change Division
1-202-343-9142
ragnauth.shaun@epa.gov