Controlling Industrial Emissions of Nitrous Oxide (N_2O) under the Montreal Protocol



OEWG46, 9 July 2024

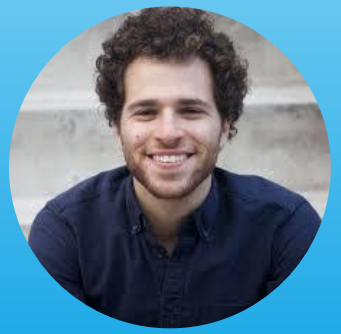
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International Nitrogen Initiative

NYU

NACAG
Nitric Acid Climate Action Group

Speakers



David Kanter

Chairperson
International Nitrogen Initiative

Associate Professor
NYU



Tom Nickson

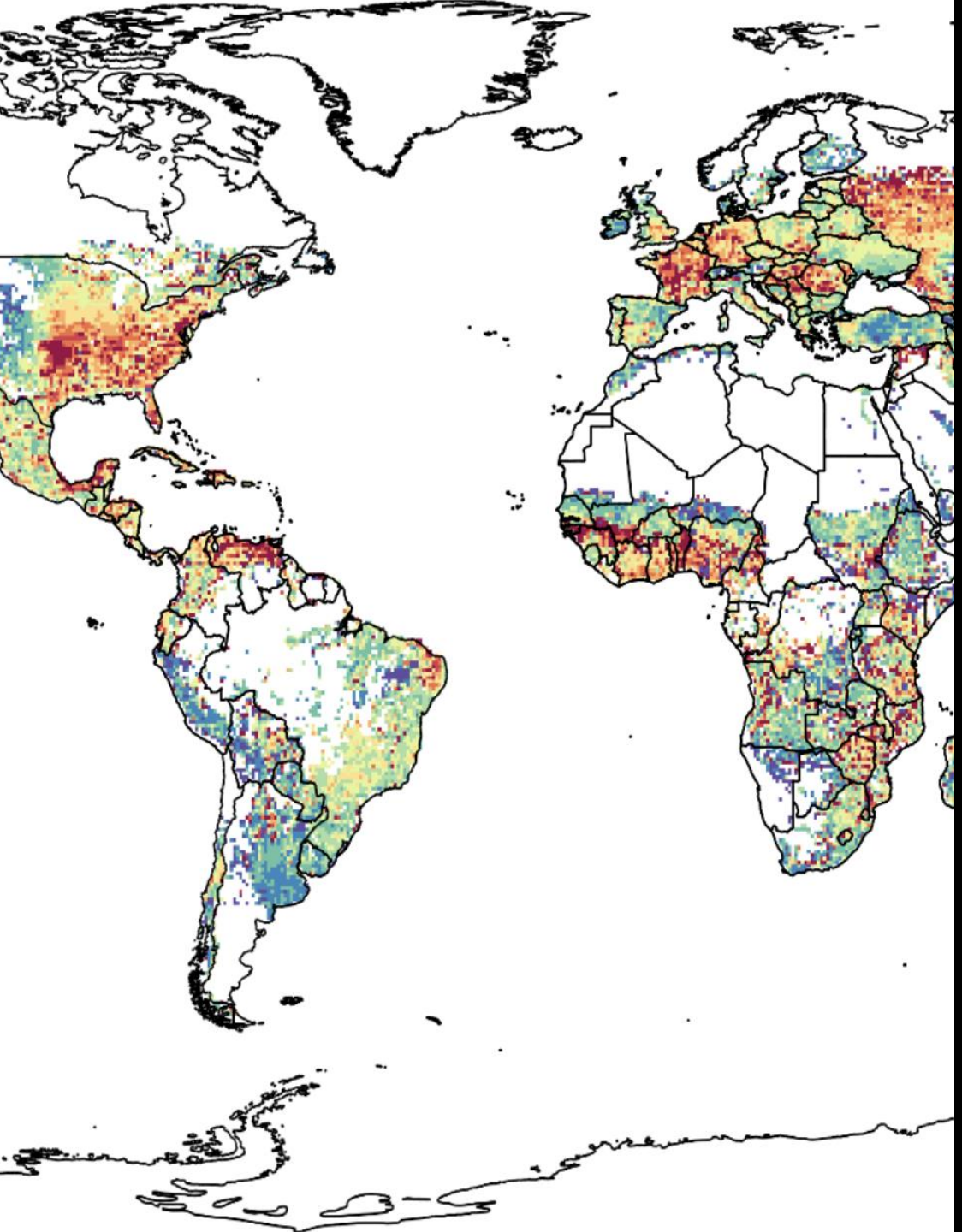
Climate Campaigner
Environmental Investigation Agency



Volker Schmidt

Senior Technical Advisor
Nitric Acid Climate Action Group (GIZ)

OEWG46, 9 July 2024



EIA side-event
OEWG Montreal Protocol

July 9, 2024

Nitrous oxide: A growing climate & ozone threat

David R. Kanter
New York University
International Nitrogen Initiative

Central points

nº 01 Nitrous oxide is most abundantly emitted ozone layer threat and third most important greenhouse gas

nº 02 Agriculture is the dominant source, fueled by fertilizer and manure, but other sources important

nº 03 Current trends higher than even worst-case scenario - but significant ozone and climate benefits to be reaped from ambitious action

nº 04 Industrial emissions are a low-hanging fruit, given limited sources and cost-efficient/technically effective abatement technologies

Nitrous oxide identified as ozone threat before CFCs

Earth's Ozone Shield May Be ImperiledBy More Fertilizer Use, Scientist Says
By JERRY E. BISHOPStaff Reporter of THE WALL STREET JOURNAL
Wall Street Journal (1923 - Current file); Nov 13, 1975;
ProQuest Historical Newspapers: The Wall Street Journal (1889-1994)
pg. 22

Earth's Ozone Shield May Be Imperiled By More Fertilizer Use, Scientist Says

By JERRY E. BISHOP
Staff Reporter of THE WALL STREET JOURNAL

ANN ARBOR, Mich —The earth's protective shield of ozone high in the atmosphere may be imperiled by man's increasing use of chemical fertilizers as well as by his use of aerosol sprays, a Harvard University scientist suggested.

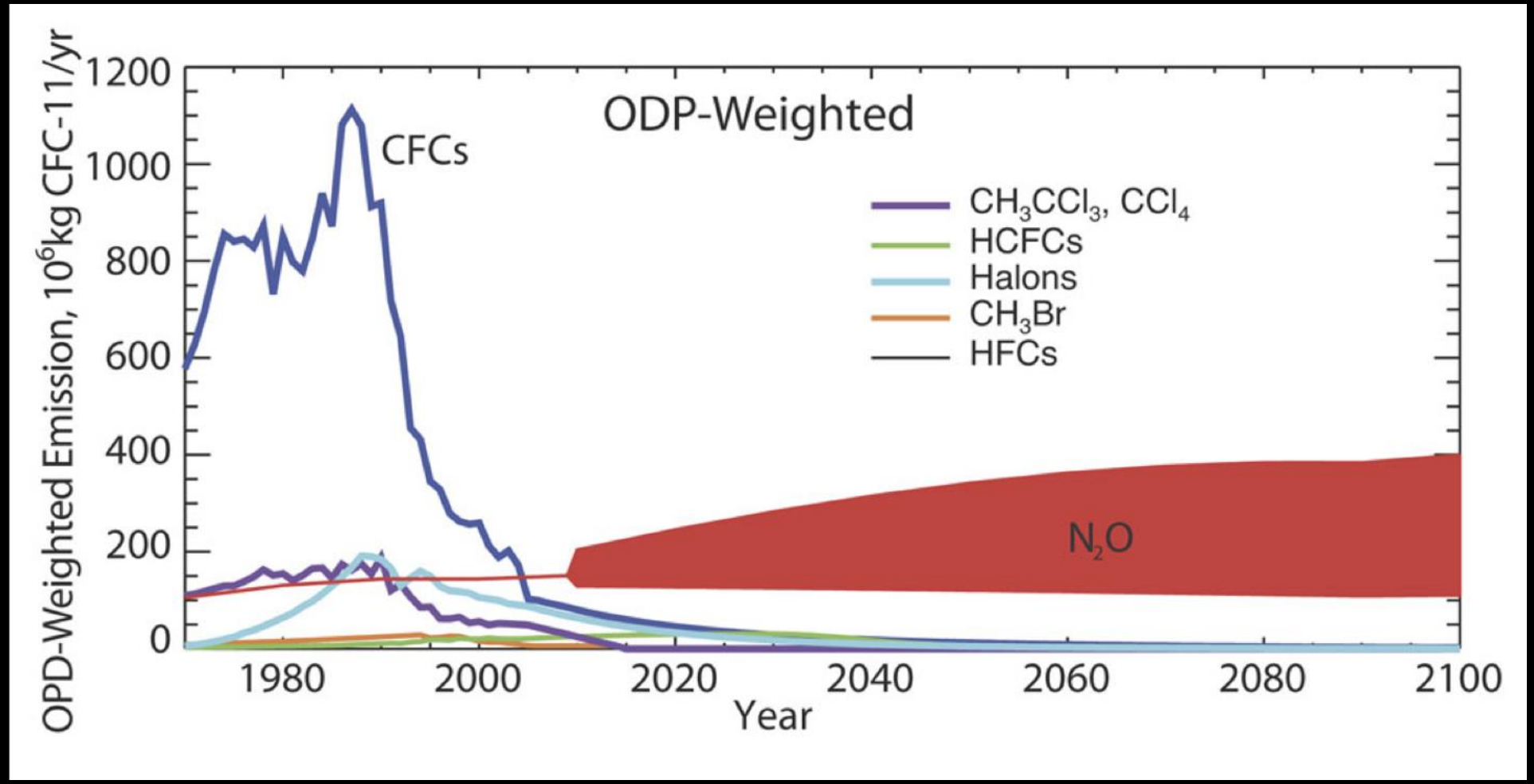
The ozone layer, composed of heavy molecules of oxygen, lies about 20 miles up and is what prevents some of the sun's more harmful ultraviolet rays from reaching the earth's surface. There is considerable concern and a raging controversy over theories that certain human activities are releasing chemicals that are damaging the ozone

and started extracting too much nitrogen from the atmosphere, the natural denitrification process to return the nitrogen would be stepped up. In the process, the ozone layer would be decreased, permitting more of the destructive ultraviolet radiation to reach the surface and bring plant life under check, restoring the balance.

The new factor, Mr. McElroy argued, is the massive manufacture and use of man-made nitrogen fertilizers To make the fertilizers, such as the nitrogen-rich ammonia fertilizers, the chemical factories extract nitrogen from the air. This nitrogen, of course, eventually goes into plant life.

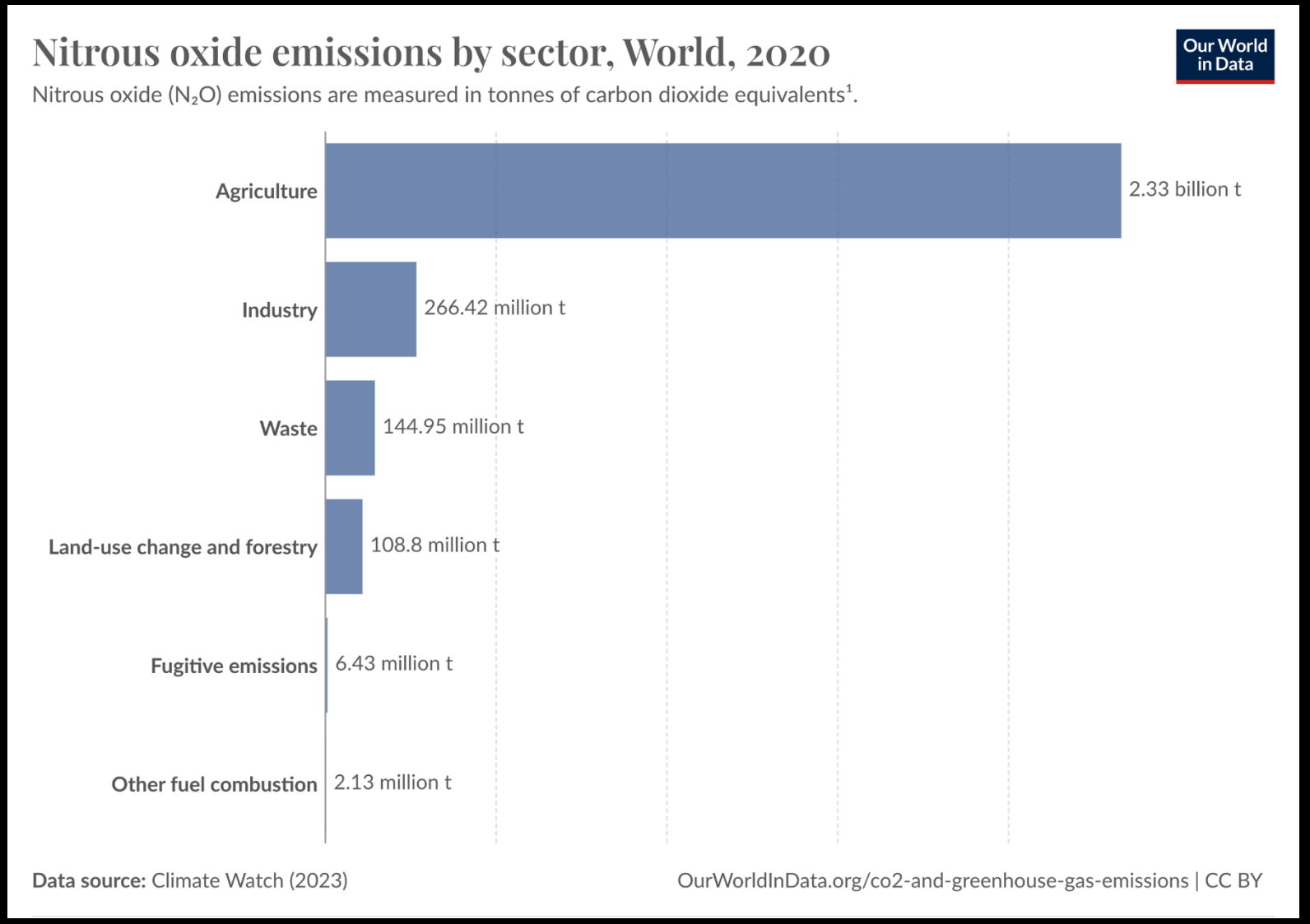
Man currently is extracting nitrogen

Most abundantly emitted threat to the ozone layer

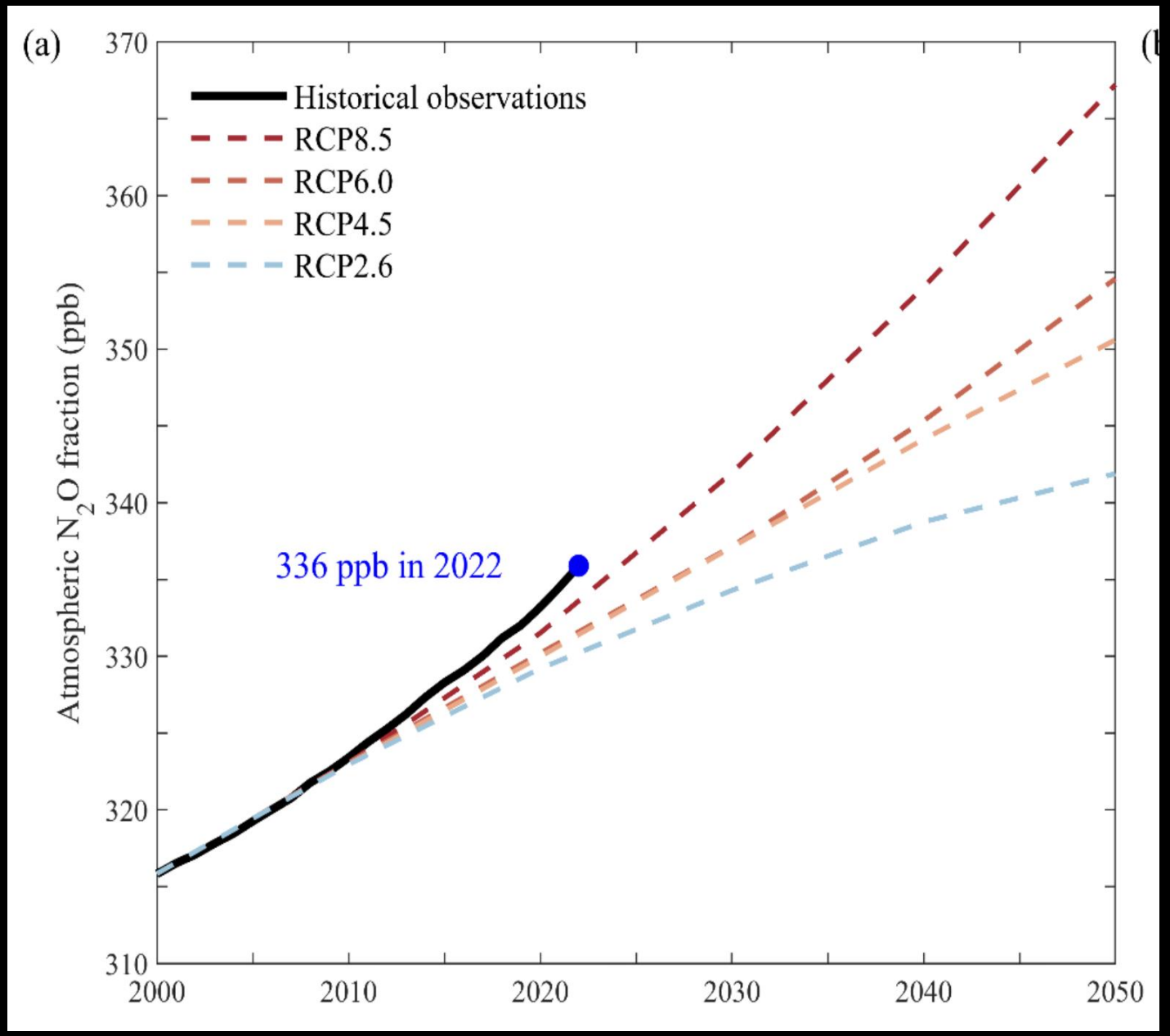


Ravishankara et al. 2009

Agriculture the largest anthropogenic source of several

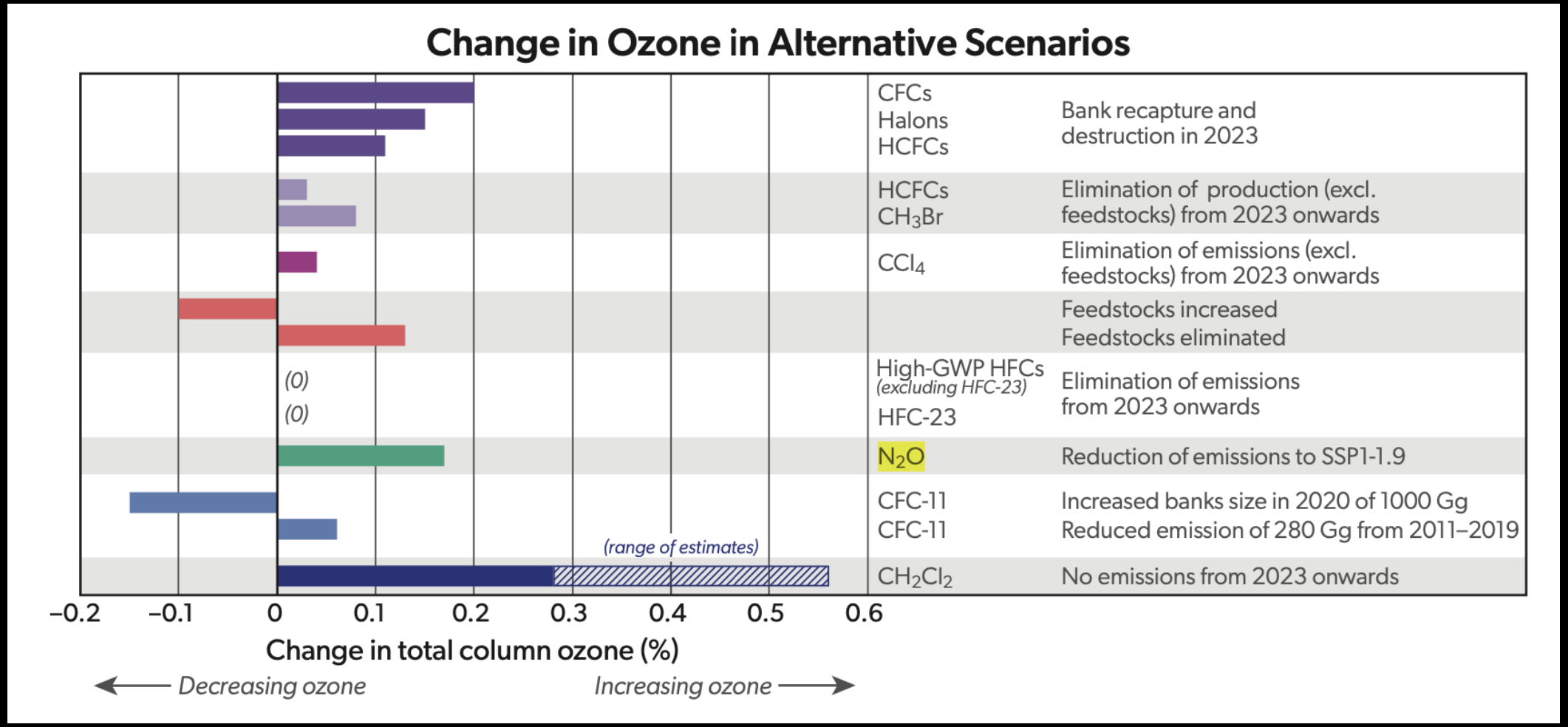


Current trends higher than even worst-case scenario



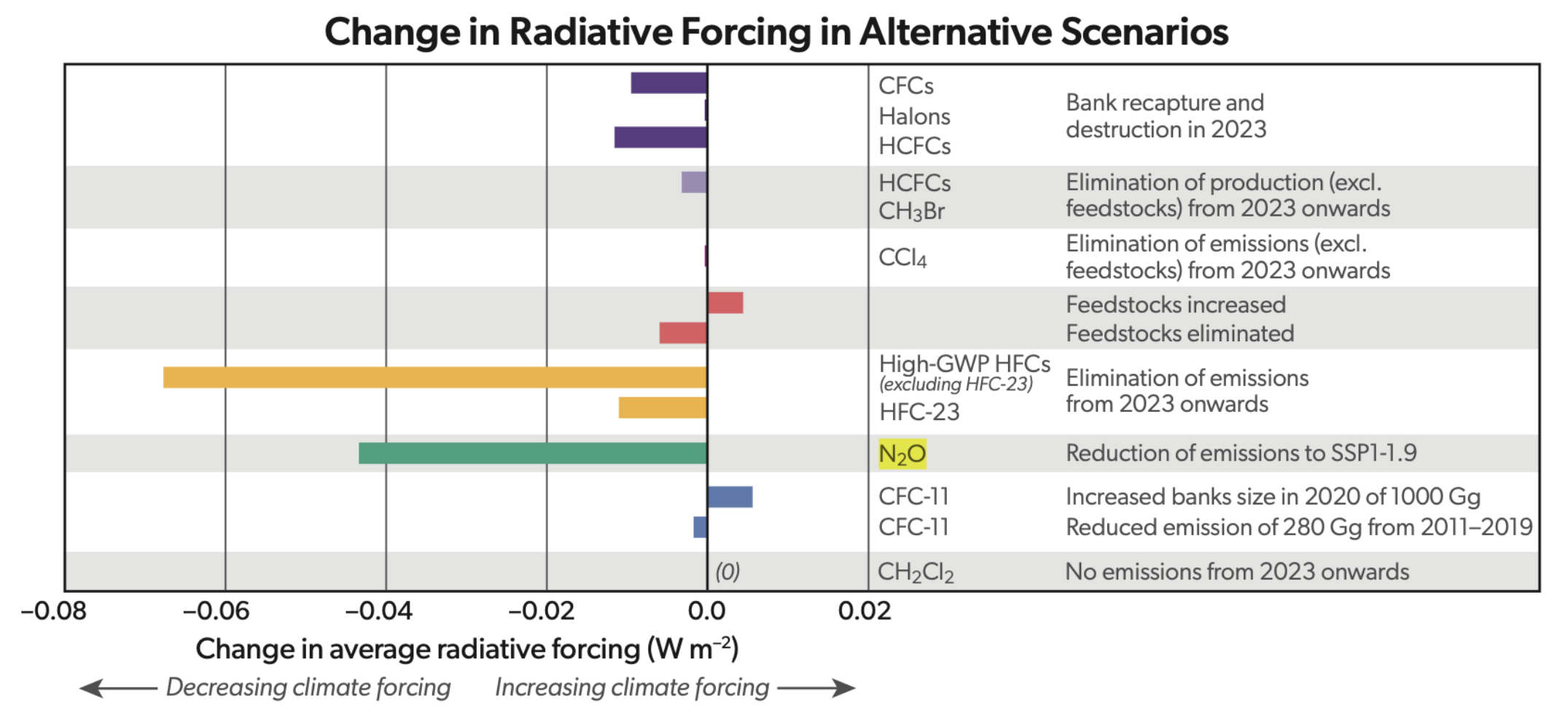
Tian et al. 2024

Ambitious N_2O abatement is an ozone action opportunity...



SAP, 2022

...and a climate action opportunity

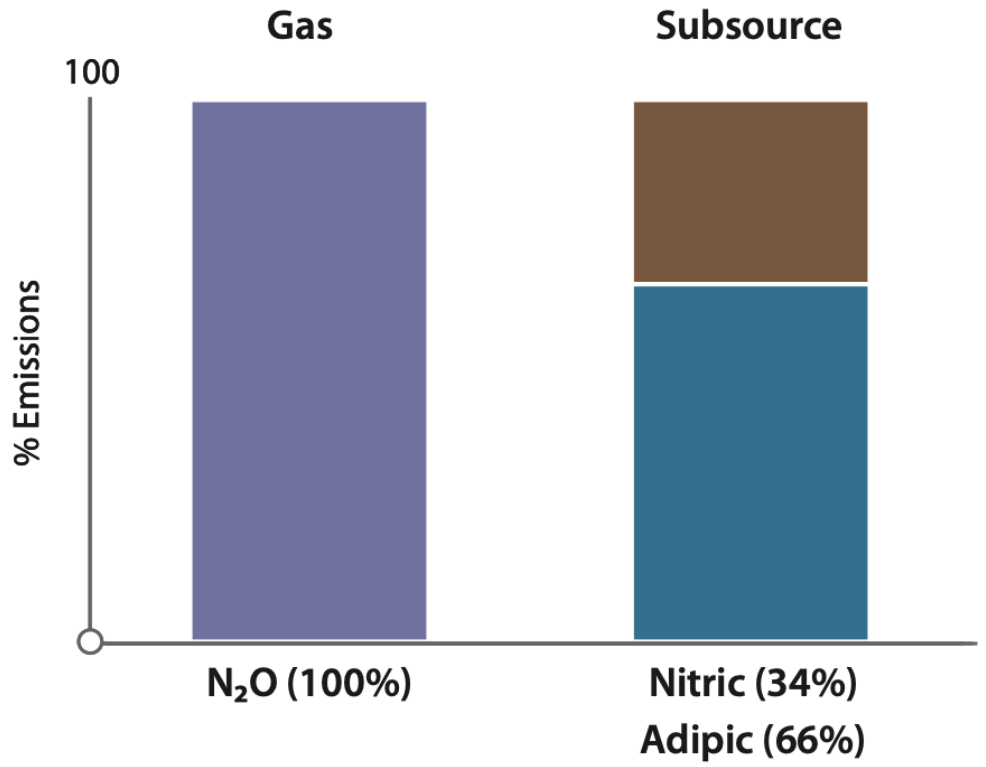


SAP, 2022

Industrial N_2O emissions are a low-hanging fruit

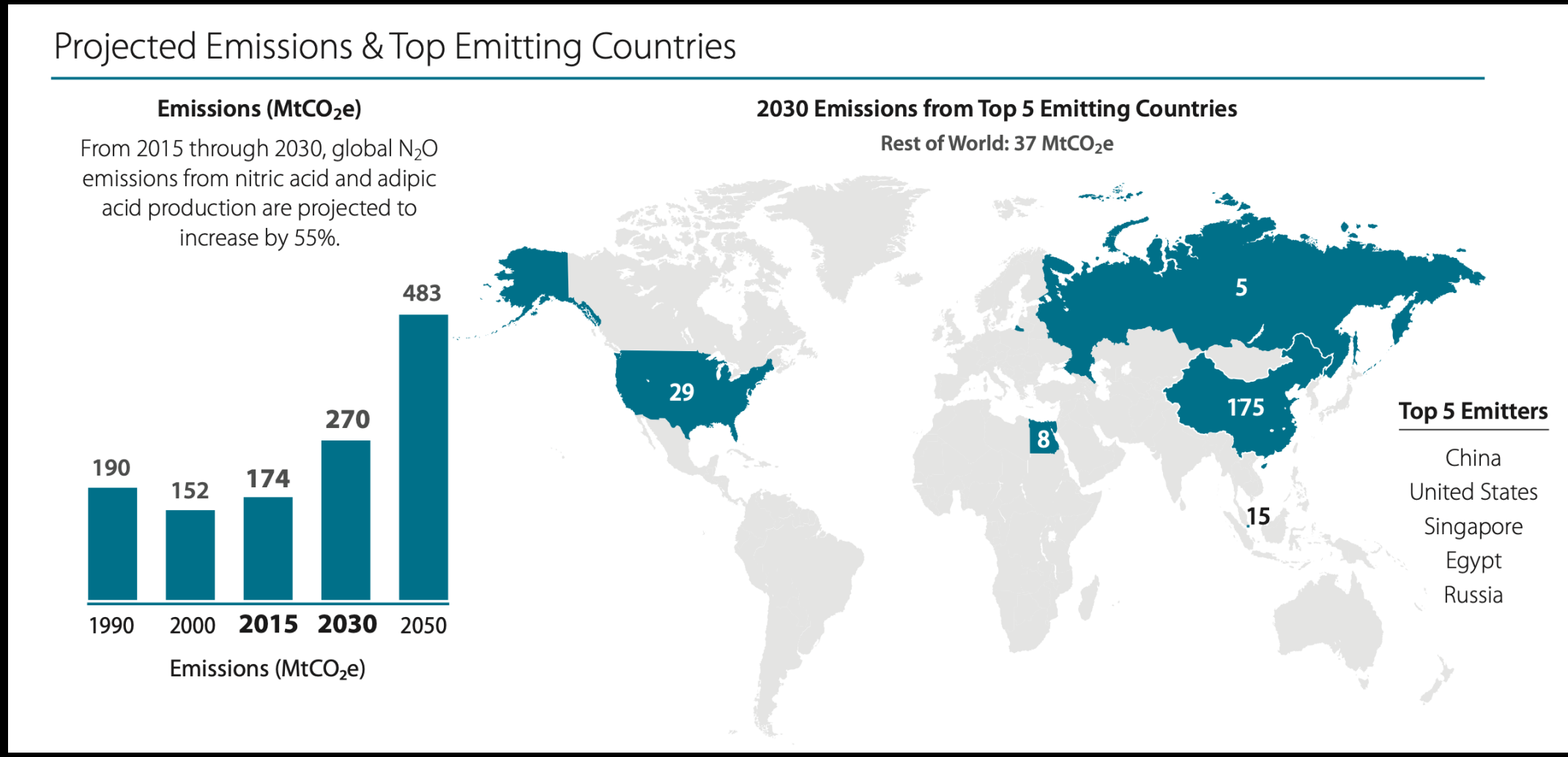
2030 Emissions by Gas and Subsource

By 2030, about two-thirds of N_2O emissions from this source category are projected to be from adipic acid production compared with about one-third from nitric acid production.[42]



USEPA, 2019

Enormous emissions increase could be avoided



USEPA, 2019

Recap

nº 01 Nitrous oxide is most abundantly emitted ozone layer threat and third most important greenhouse gas

nº 02 Agriculture is the dominant source, fueled by fertilizer and manure, but other sources important

nº 03 Current trends higher than even worst-case scenario - but significant ozone and climate benefits to be reaped from ambitious action

nº 04 Industrial emissions are a low-hanging fruit, given limited sources and cost-efficient/technically effective abatement technologies

Industrial emissions of N_2O and the Montreal Protocol

Tom Nickson – Environmental Investigation Agency

OEWG46, 9 July 2024

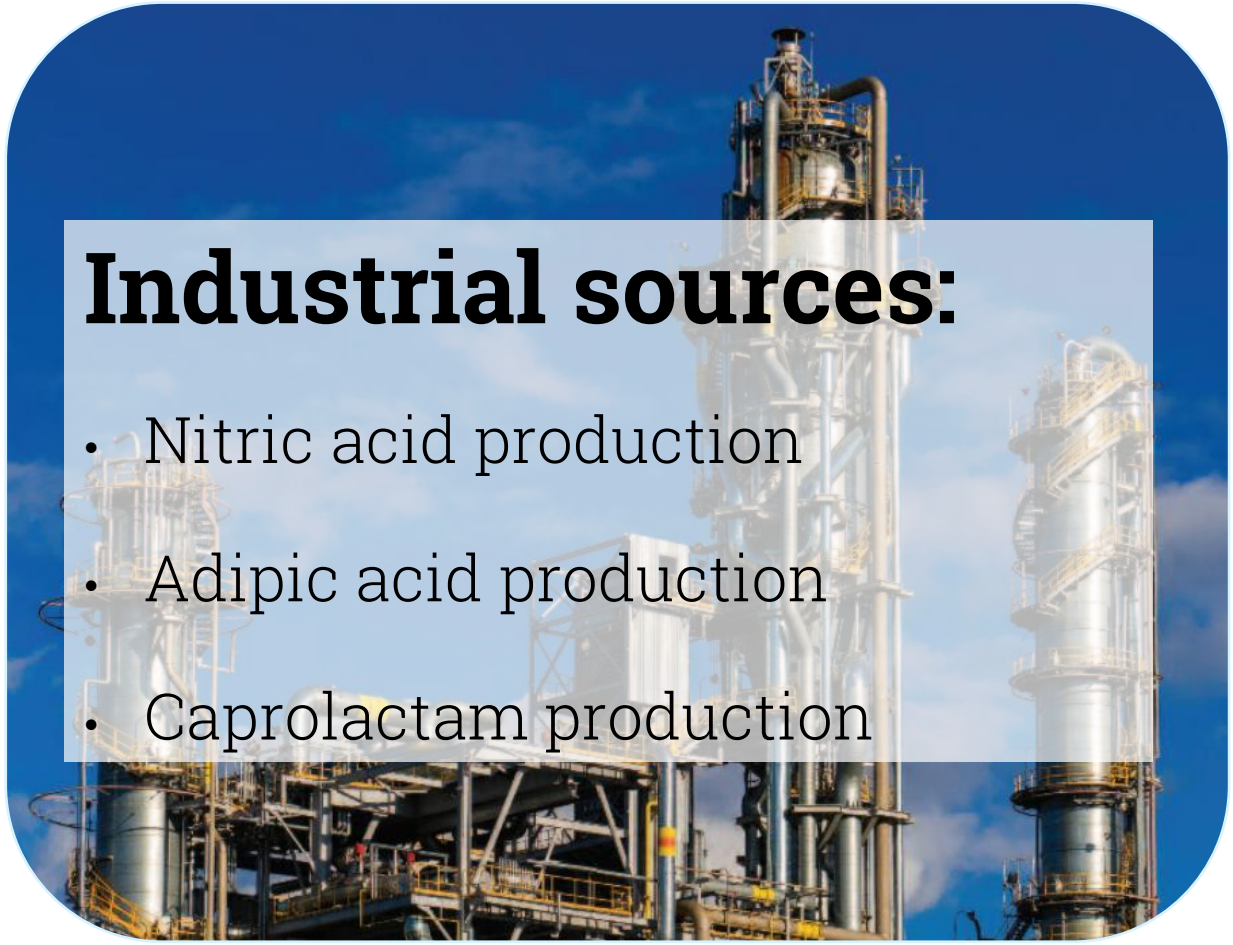
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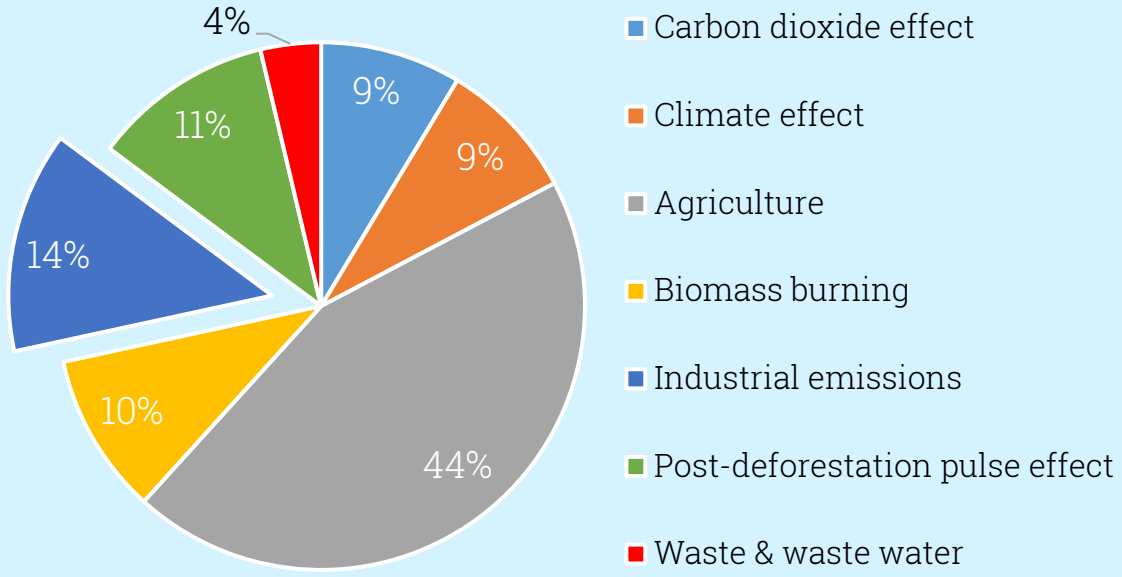
Industrial emissions of N_2O



Industrial sources:

- Nitric acid production
- Adipic acid production
- Caprolactam production

Total anthropogenic N_2O emissions



Source: H Tian, et al., (2024) Global nitrous oxide budget (1980-2020), ESSD, 16, 2543–2604

Industrial emissions of N_2O



Industrial sources:

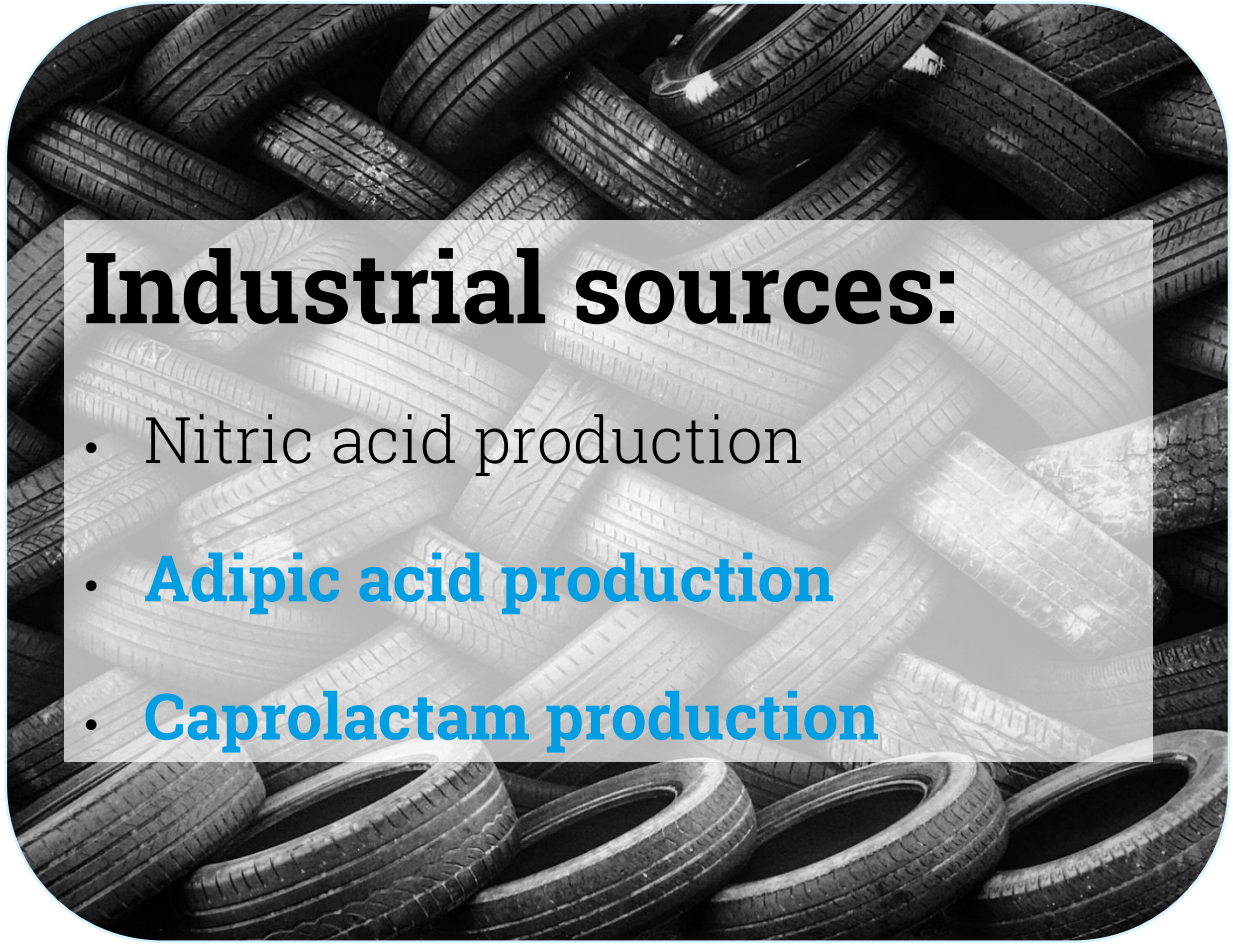
- **Nitric acid production**
- Adipic acid production
- Caprolactam production

Nitric acid

- Used in the manufacture of nitrogen-based fertilisers and explosives
- Approximately 500 plants operating worldwide, fewer than 1 in 5 have N_2O abatement technologies installed

Emissions 2015: 79 $MtCO_2$-eq
Projected emissions 2030: 92 $MtCO_2$-eq

Industrial emissions of N_2O



Industrial sources:

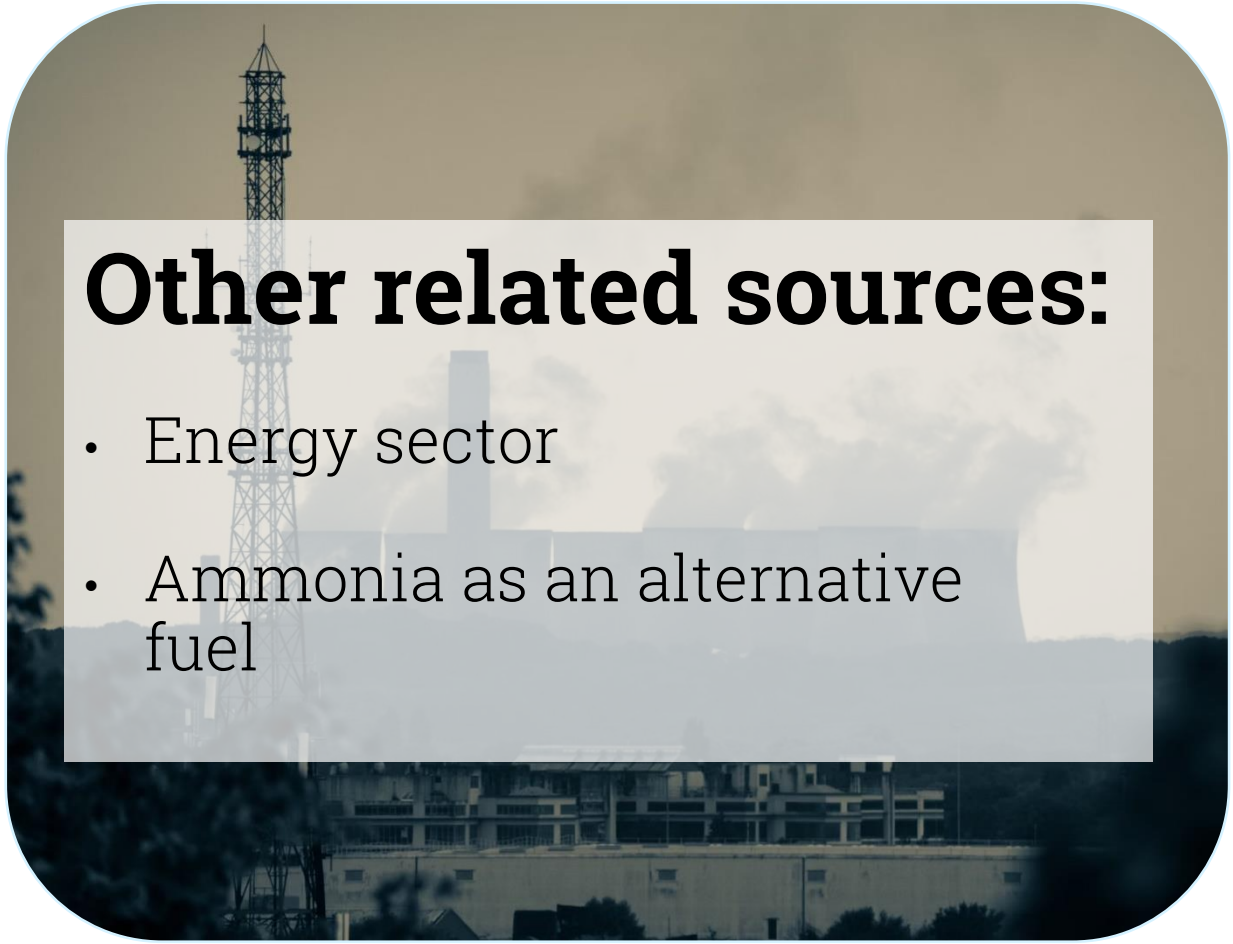
- Nitric acid production
- **Adipic acid production**
- **Caprolactam production**

Adipic acid (and caprolactam)

- Used to manufacture high-strength nylons (e.g., for tyres, carpets)
- There are around 40 plants worldwide, including at least 11 adipic acid facilities in China alone

Emissions 2015: 96 $MtCO_2$-eq
Projected emissions 2030: 178 $MtCO_2$-eq

Industrial emissions of N_2O



Other related sources:

- Energy sector
- Ammonia as an alternative fuel

Energy sector emissions of N_2O

- N_2O is emitted whenever fossil fuels are burned, although extent to which varies
- Annual emissions from energy production estimated to total **~225 MtCO2-eq**

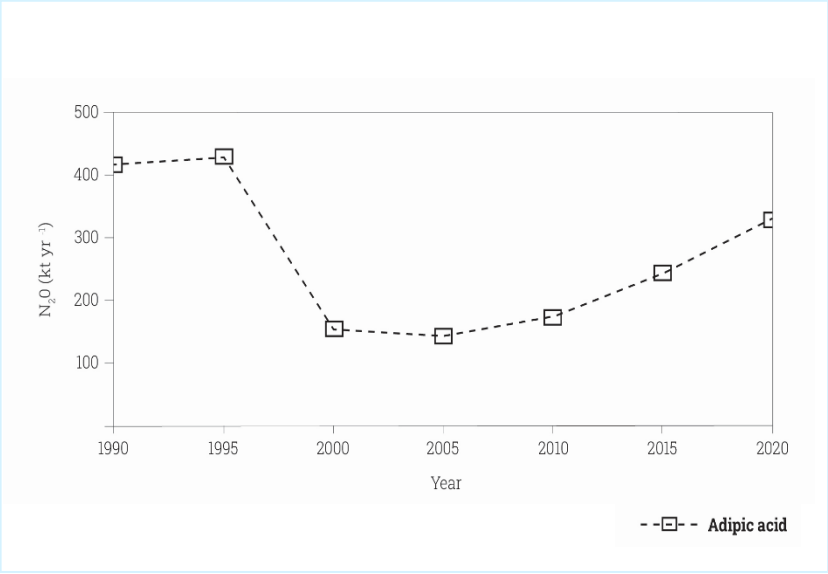
Ammonia as an alternative fuel

- "Green" ammonia being touted as a potential carbon-free fuel source
- Potential for high N_2O emissions would offset this benefit unless abatement developed and regulated

Industrial emissions of N_2O

Abatement of industrial emissions

Using existing, low-cost abatement technologies – already employed in many plants and facilities across the world, and already required by regulation in some regions – **industrial emissions of N_2O can be reduced to nearly zero**.



Source: Davidson, E.A., Winiwarter, W. Urgent abatement of industrial sources of nitrous oxide. Nat. Clim. Chang. 13, 599–601 (2023).

- **US EPA estimates that ~80% of the total abatement potential for industrial emissions of N_2O is achievable at break-even prices below $20**
- **Other studies suggest even better prospects, estimating that abatement potentials >95% could be achievable in many adipic acid facilities at below $11/t$CO_2$-eq**

← **Emissions from adipic acid production based on GAINS model**
Increase follows collapse of the Clean Development Mechanism, after gaming of the system was exposed.

Industrial emissions of N_2O

environmental investigation agency

Controlling industrial emissions under the Montreal Protocol

With its successful track record in phasing out CFCs & HCFCs, and its legacy of increasing environmental and climate ambition, **the Montreal Protocol is uniquely well-suited** to address the challenge posed by industrial emissions of N_2O.



Credit: Center for Land Use Interpretation Database
https://clui.org/ludb/site/pensacola-chemical-complex

- **Under the Kigali Amendment, Parties must ensure any HFC-23 byproduct emissions are "destroyed to the extent practicable using [approved technologies]"**
- **A similar approach could be applied to address byproduct emissions of N_2O generated during industrial chemical production**

← **Adipic acid production facility in Pensacola, Florida (USA)**
The Ascend Performance Materials facility pictured emitted over 9,000,000 tCO_2-eq of N_2O in 2018.

Industrial emissions of N_2O

Conclusions & recommendations

- Request the **Ozone Secretariat to engage with relevant stakeholders on the topic of controlling industrial N_2O emissions** under the Montreal Protocol
- Request the **TEAP to produce a report on the technical feasibility, economic costs and ozone & climate benefits** associated with the abatement of N_2O emissions from industrial sources
- Request the **SAP to produce a targeted report on the ozone and climate impacts of N_2O emissions from all sources** and to outline the projected trends for such emissions

Questions…



Tom Nickson

Climate Campaigner
Environmental Investigation Agency

EIA's briefing on industrial emissions of N_2O – Taking Industrial Action – is available at:

www.eia-international.org/climate/reports-climate

Contact: tomnickson@eia-international.org

Nitric Acid Climate Action Group

Tapping the potential to abate N_2O emissions from nitric acid production globally

OEWG46, 9 July 2024

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

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NACAG Nitric Acid Climate Action Group

Nitric acid production and its impact on the climate

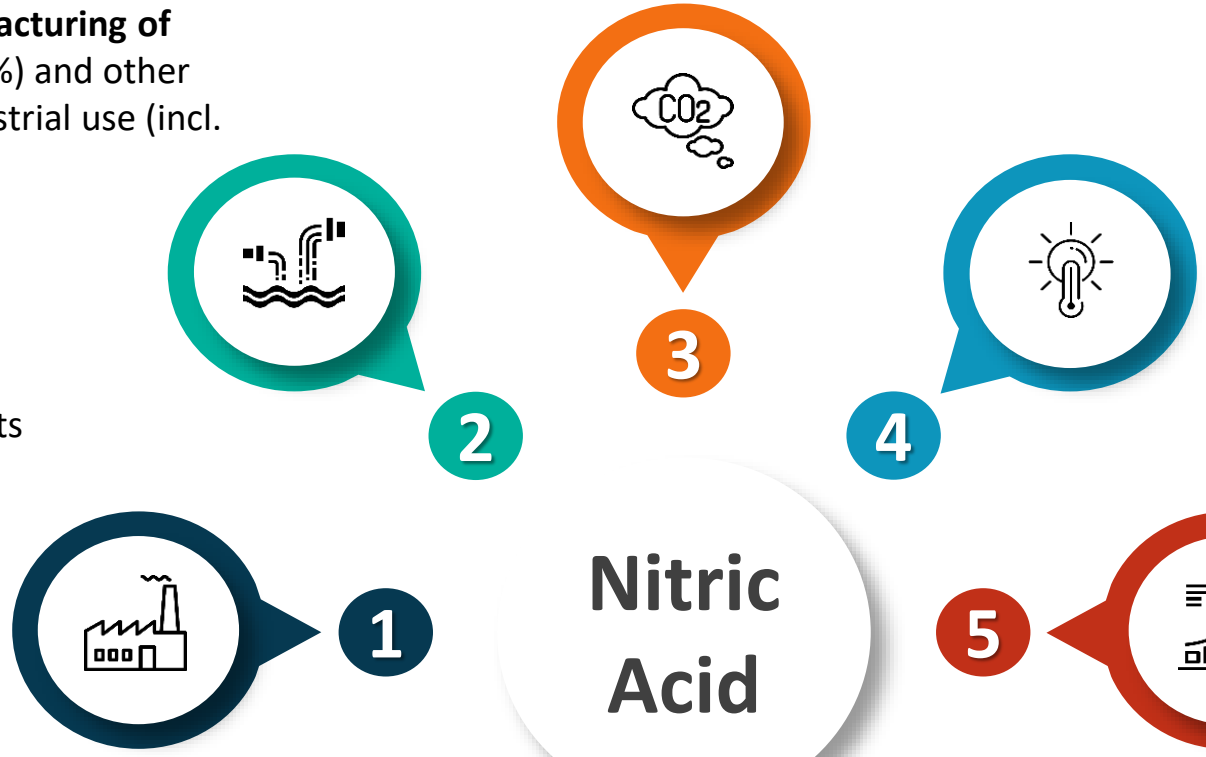
GHG Emissions

Nitrous oxide (N_2O) is an unwanted by-product in the production of nitric acid, with a heating potential **273 higher than CO_2.**

+ by now also most prevalent ozone depleting substance

Use

Mainly for **manufacturing of fertilizers** (ca. 80%) and other products for industrial use (incl. Explosives).



Production

Approx. **500 production** plants worldwide manufacturing around 6.5 **Mton HNO_3** (own estimates).

Mitigation Potential

Global nitric acid sector has an average annual emissions mitigation potential of **above 100 million tCO_2eq**

Growth

The sector has grown between 2000-2016 at an average rate of **2% per year** (IHS Markit).

NACAG: Background and Objectives

Supported by:

Federal Ministry for Economic Affairs and Climate Action

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on the basis of a decision by the German Bundestag

Official announcement during COP21 in Paris by BMU - launched end 2016

Vision

Reduction of global nitrous oxide emissions from nitric acid production – all plants worldwide to be equipped with effective abatement technology.

Technical support and regulation

To offer technical support to plant operators and governments, in terms of abatement technology and policy for the regulation of the sector.

Funds

Funds secured by €50 M administered by GIZ - Action Group set-up was to allow other funding partners.

SoU and NDCs

Ensure long.-term commitment on abatement of N_2O emissions from nitric acid and to be included in the NDCs.

Financing

Finance technology for the abatement of N_2O emissions and monitoring systems. Note: Available for ODA recipient countries.

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Opportunities in the nitric acid sector

COMPARATIVE COSTS

Relatively easy to implement and low/moderate cost of abatement technologies (1-5€/tCO_2eq)

CENTRALIZATION

Limited number of plants (approx. 500 units worldwide)

CDM APPLICATION

Successful sector in the CDM (97 registered projects, 54 projects have issued > 71 million CERs)



HIGH POTENTIAL

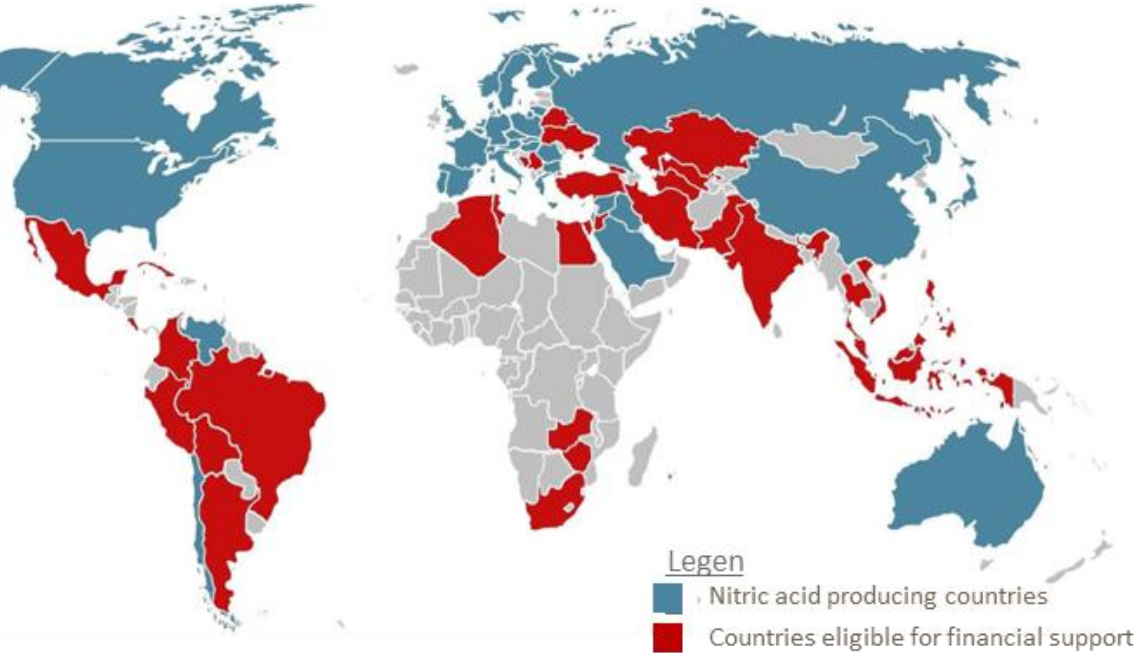
Significant abatement potential (> 100 million tones of CO_2eq/year globally

EXPERIMENTATION

Well proven abatement technology readily available (CDM / JI / EU-ETS)

Pilot sector -> if successful, possibility to be scaled to other sectors

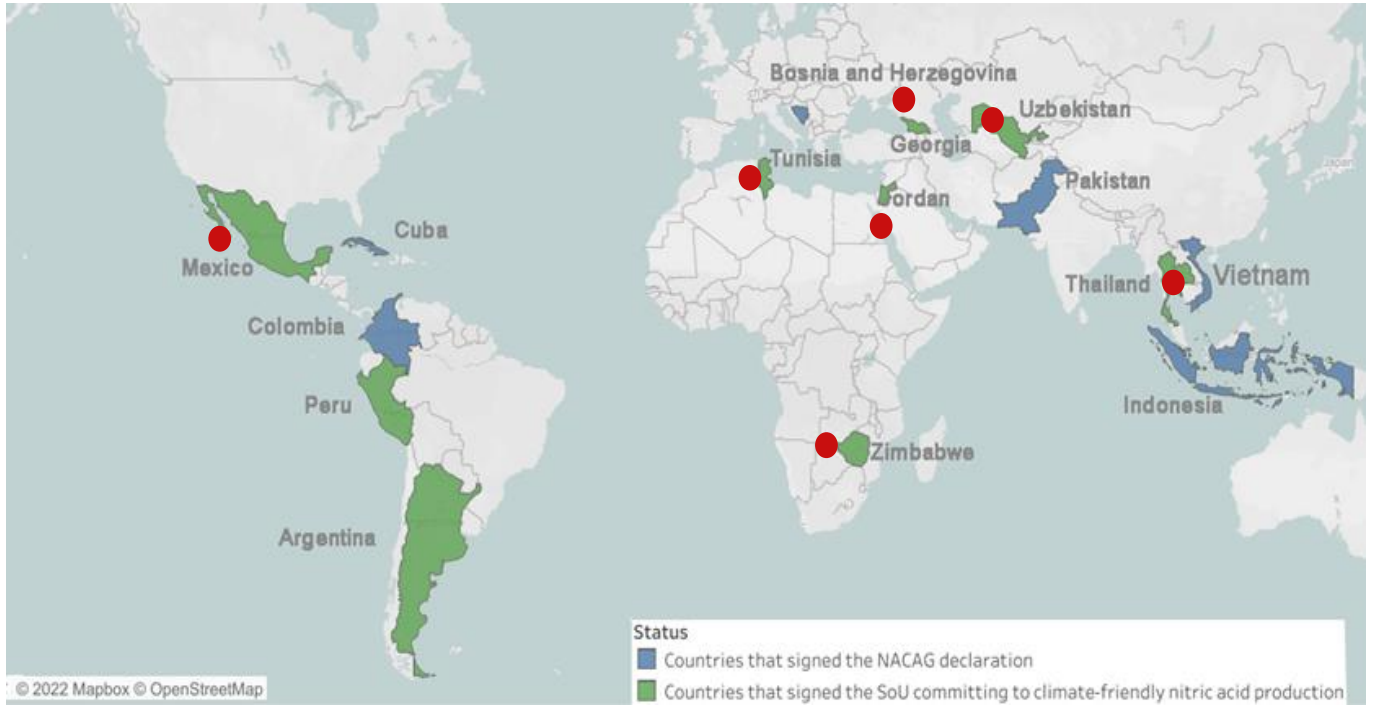
NACAG implementation status



- 10 countries signed Statement of Undertaking (SoU) committing to permanently abate N_2O emissions from nitric acid
- So far 10 Grand Agreements signed



- 30 countries and +100 eligible plants for finance support
- 12 countries signed NACAG Declaration expressing support to the goals of the initiatives



- Countries where tender processes are in progress: Zimbabwe, Tunesia, Mexico, Georgia, Jordan, Uzbekistan, Thailand

CASE EXAMPLE
Implementation status in Mexico

Nitric Acid production	Mitigation potential	Tendering processes	Governmental commitment
➢ ***3 nitric acid plants*** operating in Mexico	➢ Combined mitigation potential of ***400.000 tCO_2eq per year***	➢ ***1 contract*** for Monitoring Equipment already signed	➢ N_2O emissions from NA sector ***included in Mex. NDC in 2022*** (through NACAG support)
➢ ***2*** plant operators have already ***signed a Grant Agreement*** with NACAG in 2022		➢ ***1*** plant just ***finished the tender*** for the acquisition of abatement technology	➢ ***Policy mechanisms for permanent reduction of N_2O in discussion***



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Soluciones Químicas NAP: N_2O abatement… and beyond!

Grant Agreement signed in July 2022

Tender processes successfully completed (installation April 2025)

Expected abatement of **110.000 tCO_2eq** at technical abatement costs **below 1 €/ton CO_2eq**



CO-BENEFITS ALONG THE IMPLEMENTATION (e.g. Due Diligence Process)**:**

- Improved communication/relationship with residential areas
- study to identify areas at risk for contamination of soil, groundwater and surface water bodies
- Improving safety conditions at workplace
- Know-how / capacity building
- Enhancing capacities with national suppliers of N_2O monitoring equipment services

NACAG: SUCCESSES

ACHIEVEMENTS

- Brought issue on the international agenda (>30 governments, studies and presentations)
- 10 (+ 3?) countries **signed SoU**, many of them regarded sector in NDC
- 10 (+ 3 to 5 more) **Grand Agreements signed**
- Policy advisory, capacity building and development (e.g. MRV)

EXPECTED OUTCOMES

- ***3-5 million tCO_2eq of permanent annual emission reductions (equal to app. 11.300 – 18.800 tN_2O/yr)***

Production related N_2O emissions under the MP?

Not only a good idea but a great OPPORTUNITY

- Low cost, availability of proven abatement technologies and high mitigation potential make N_2O from nitric and adipic acid a ***real "low hanging fruit"*** from GHG but also Ozon Protection perspective (app. 250 million tCO_2eq/yr or almost 1 million t N_2O/yr)

- Only ***a binding global agreement/treaty*** is capable to cover complete sectors while creating a ***level playing field*** and at the same time ***enable enforcement***

- Rules out most limitations of small projects/initiatives (lengthy processes) being able to harvest ***full mitigation potential and unfold low-cost effectiveness*** (cost estimates for adipic acid go as low as 0.1 EUR/tCO2eq or 2.73 EUR/tN_2O)

- ***Real catch*** → Two complete sectors mitigating two extremely negative impacts at the same time;
  technical abatement not replacement → no risk for counter effects/leakage

- ***No time to lose!***

Questions?

Contact:
Volker Schmidt
Senior Technical Adviser
NACAG Secretariat
T + 49 30 338424-647
E volker.schmidt@giz.de
www.nitricacidaction.org



Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Sitz der Gesellschaft
Bonn und Eschborn

Friedrich-Ebert-Allee 36 + 40
53113 Bonn, Deutschland
T +49 228 44 60 - 0
F +49 228 44 60 - 17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn, Deutschland
T +49 61 96 79 - 0
F +49 61 96 79 - 11 15

E info@giz.de
I www.giz.de

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Thank you!

To access EIA's briefing on industrial emissions of N_2O, scan the QR code below

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