National Institute for Public Health
and the Environment (RIVM)
Ministry of Health, Welfare and Sport
The Netherlands

Future atmospheric abundances and climate forcings from HFC scenarios

Guus Velders (PhD)	RIVM, NL
David Fahey (PhD)	NOAA, USA
John Daniel (PhD)	NOAA, USA
Stephen Andersen (PhD)	IGSD, USA
Mack McFarland (PhD)	Chemours,USA

Utrecht, InGOS, September 23, 2015

Take home message

New HFC scenarios: 11 regions, 13 sectors, 10 HFCs

- Business-as-usual emissions 4.0-5.3 $GtCO_2$-eq/yr 2050
  - 9-29% of increase in annual CO_2 emissions from 2015 to 2050
- Mainly in developing countries in refrigeration and stationary AC

Regulations in EU, USA and Japan reduce their national 2050 emissions by 45-75%

Montreal Protocol Amendment proposals reduce 2050 emissions by 50-90%

HFC business-as-usual scenarios

Historical consumption developed countries

- UNFCCC/CRF: **Emissions** and **stocks** per country, sector, HFCs, year
  ➔ consumption data and emission factors
- "Complete" for all **refrigeration** and **air conditioning** sectors
- Limited information for foams, aerosols, fire extinguishing, solvents

Historical consumption developing countries

- Published consumption data for China
- HFC consumption for mobile AC, domestic refrigeration

Historical HCFC consumption from UNEP

- Replacement of HCFCs with HFCs and not-in-kind alternatives

Shared Socioeconomic Pathways as drivers for HFC demand

Consumption constrained by observed mixing ratios

Emissions inferred from observations

Robust information

- Inferred from **observed** global mean mixing ratios

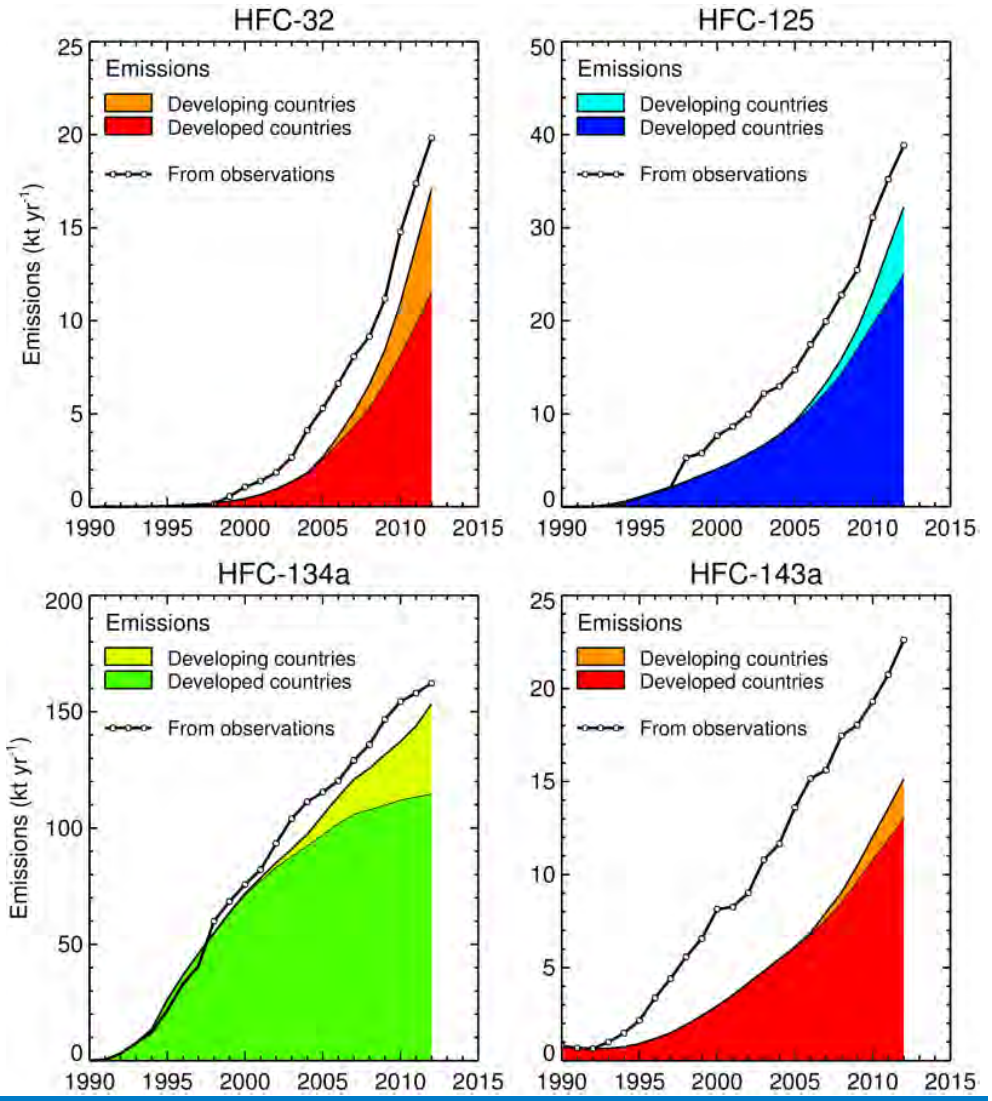
Bottom-up emission

- Calculated from consumption data and emission factors

- About 50% from reported UNFCCC data in developed countries
- Significant contributions from developing countries in recent years

Consumption adjusted

- In new scenarios the **gap is closed** by adjusting the consumption

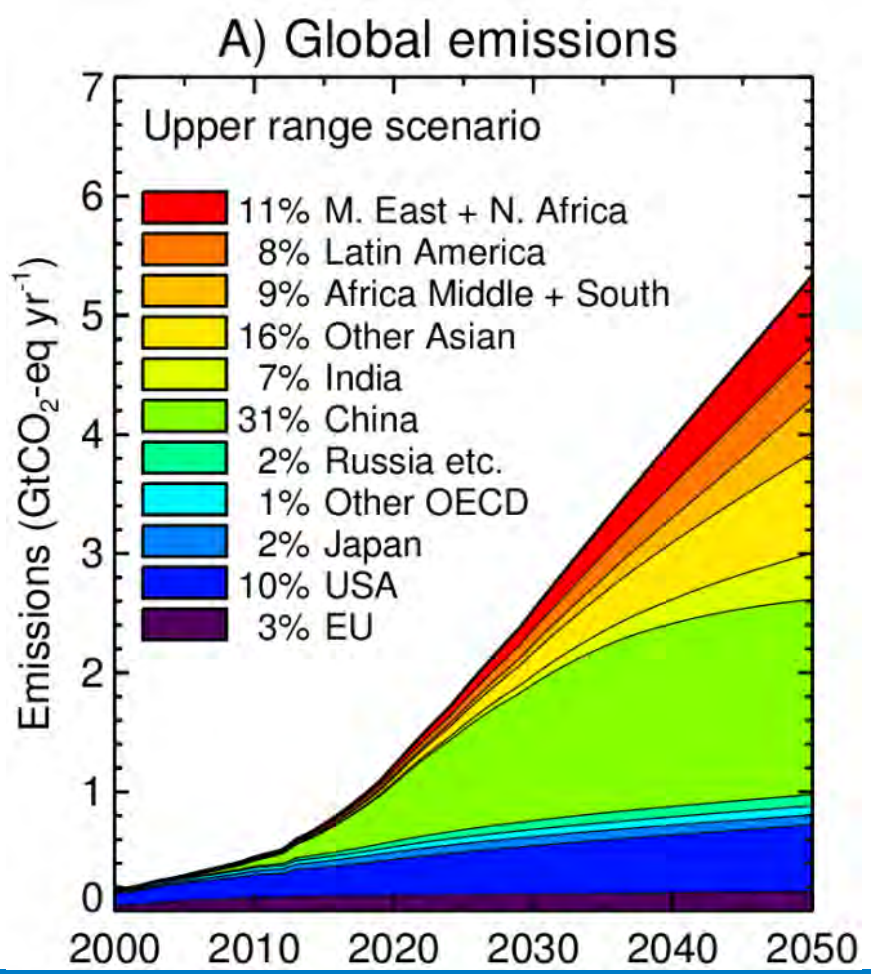


Business-as-usual emissions for each region

Major 2050 emissions from developing countries

- Historical emissions mainly from USA and EU

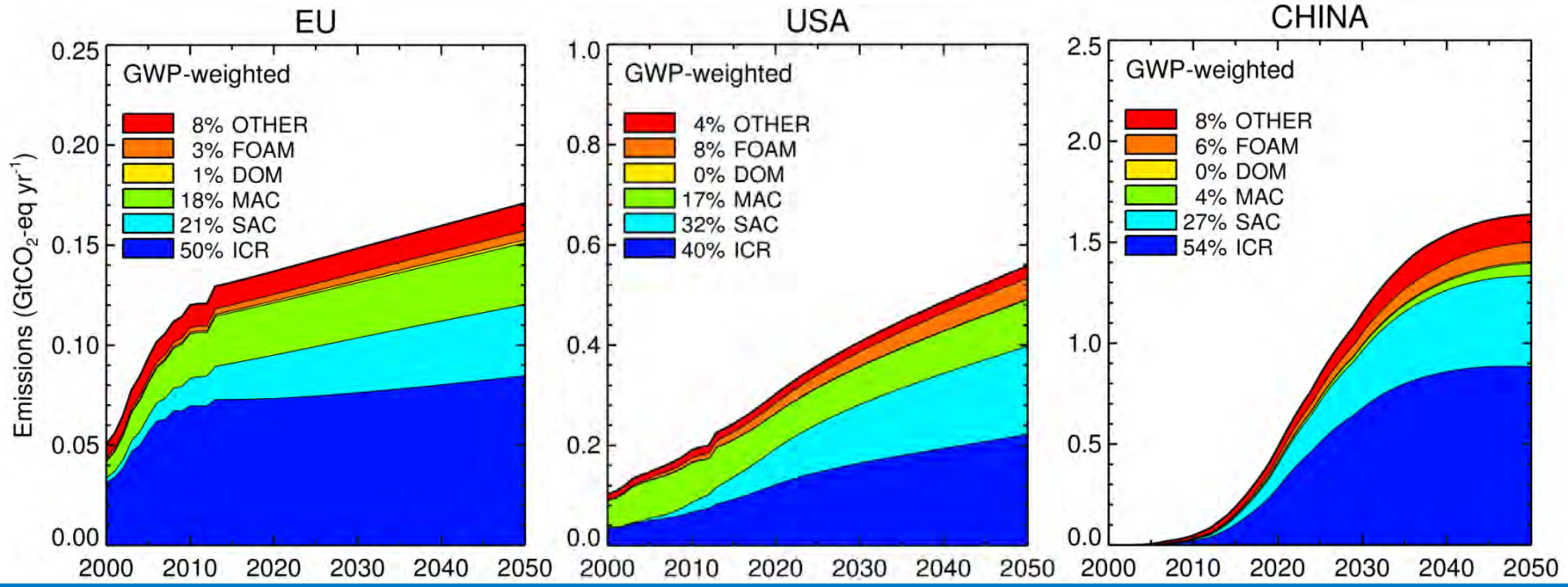
- China is projected to be largest emitter in 2020
- Major regions in 2050
  - China (31%)
  - Other Asian countries (23%)
  - USA (10%), Middle East - N. Africa (11%)



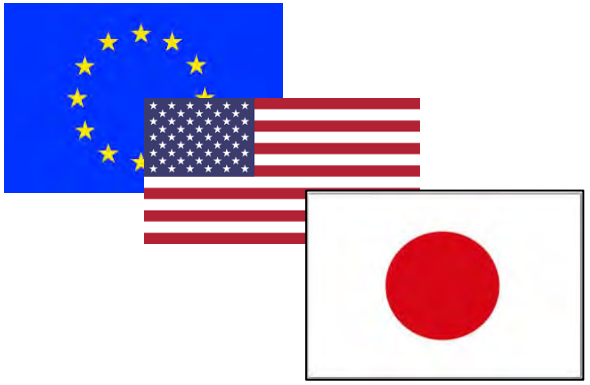
Business-as-usual emissions per region

CO_2-eq emissions

- Main developed country regions: USA, EU
- Main developing country regions: China, other Asian countries
- Main sectors:
  - ICR: Industrial and commercial refrigeration
  - SAC: Stationary AC
  - MAC: Mobile AC (only for developed countries)



National/regional regulations



Regulations in force or proposed

- EU: Revised F-gas regulation + MAC directive
- USA: Changes to SNAP list
- Japan: F-gas controls
- Also discussion in Canada, Australia

- Some assumption were made on how much HFC use in sector is covered by these regulations

- Effects of the national regulation on the local emissions

National regulation will drive global technological changes

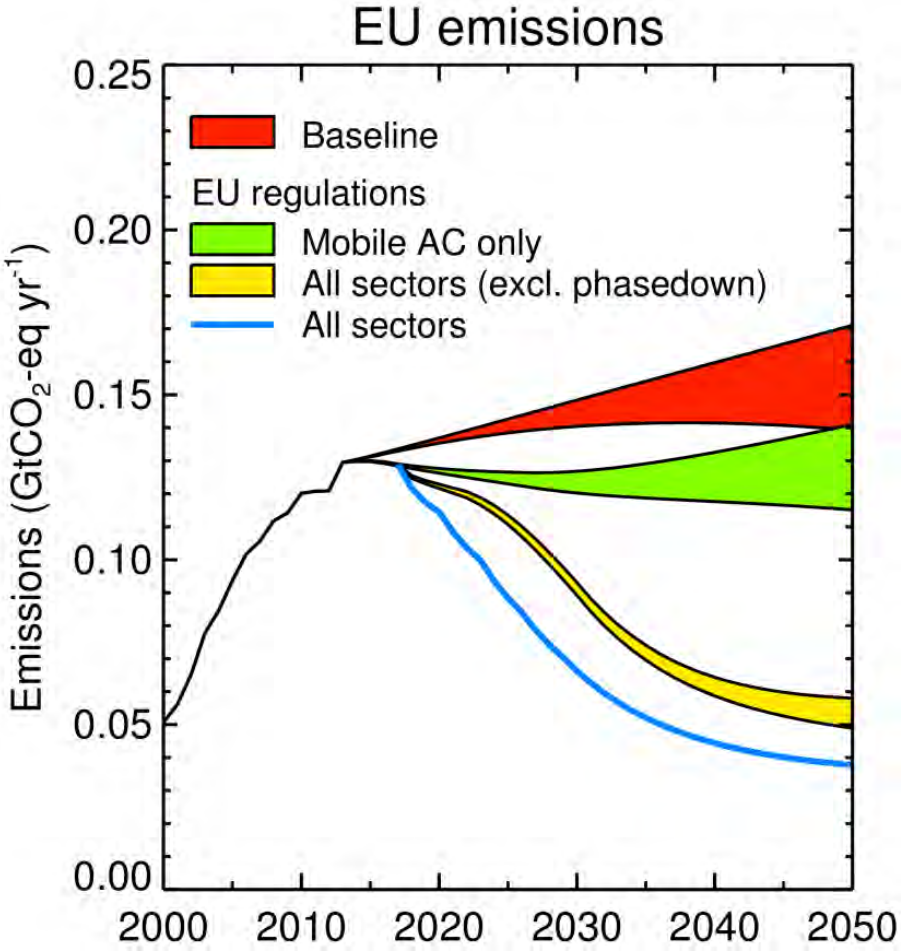
- Effects of the national regulation on emissions in developed and developing countries

Emissions from the EU

Revised EU F-gas regulation

+ MAC directive

- Bans on high-GWP HFC use for
  - Domestic and commercial refrigeration
  - Stationary AC
  - Mobile AC
  - Foams, aerosols
- Phase-down to 21% of base level in 2030
- Reductions in 2050 emissions:
  - 17% from MAC
  - 48% from bans in other sectors
  - 10% from phasedown
  - **Total 75% or 0.10-0.13 $GtCO_2$-eq/yr**



Montreal Protocol amendment proposals

Proposals submitted

- Canada, Mexico, USA
- EU
- Pacific island states
- India

Contents

- Including HFCs in Montreal Protocol (keep also in Kyoto)
- Baseline based on HFC + HCFC production/consumption
- Phasedown from baseline levels to ~15% in ~2035
- Grace period for developing countries of 10-15 years
- Differences between proposals in baseline in grace period

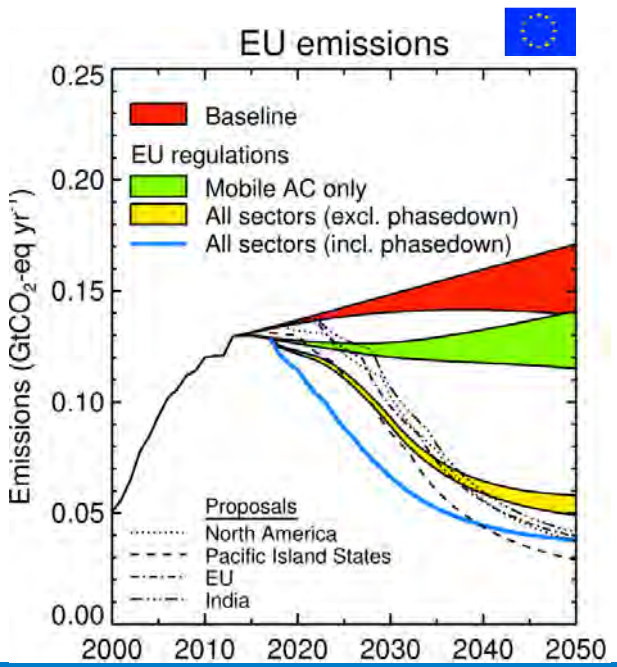
Possible decision at next meeting in Dubai in November

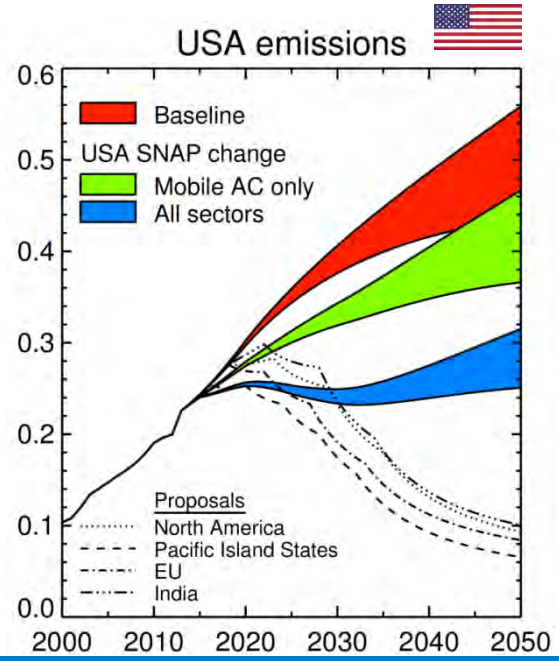
- Strong support from more than 150 countries
- Opposition by few countries: Saudi Arabia and neighbors
- Energy efficiency has to be considered too !!

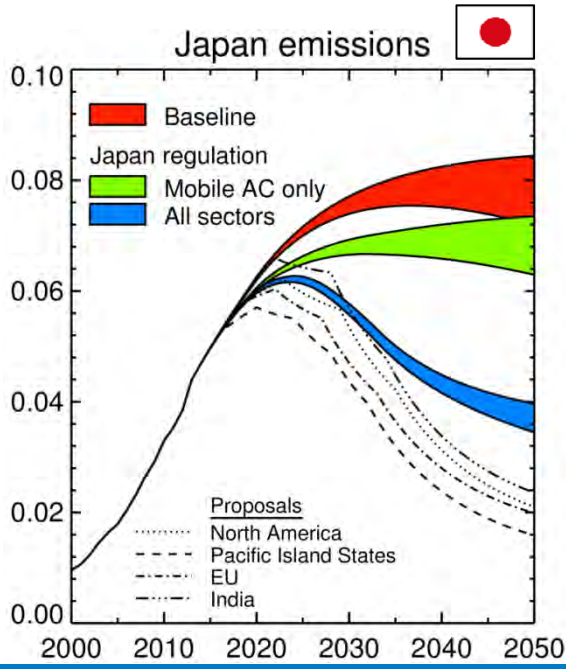
Regional impacts of regulations vs MP proposals

Reductions in national emissions bridge the gap in part

- EU: Regulations sufficient to reduce emissions to MP targets
- USA: Proposed SNAP change reduces emissions to about half the MP proposals
  - No limits for stationary AC
- Japan: Regulations reduce emissions by about two-thirds of the MP proposals





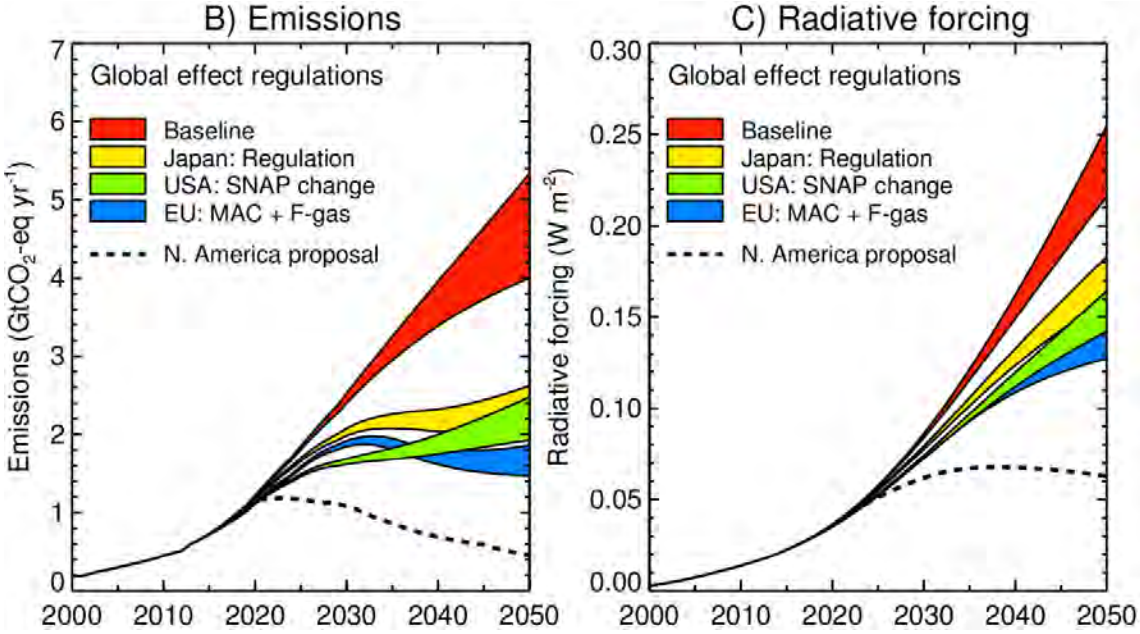


Global impacts of national regulations

New technologies being developed to meet national regulations

- Global adoption of technologies required to meet national regulations is likely
- Developing countries assumed to follow developed countries after 5 years
- Comparison with North American MP amendment proposal

- Consumption and emissions more or less stabilize
- Radiative forcing continues to increase



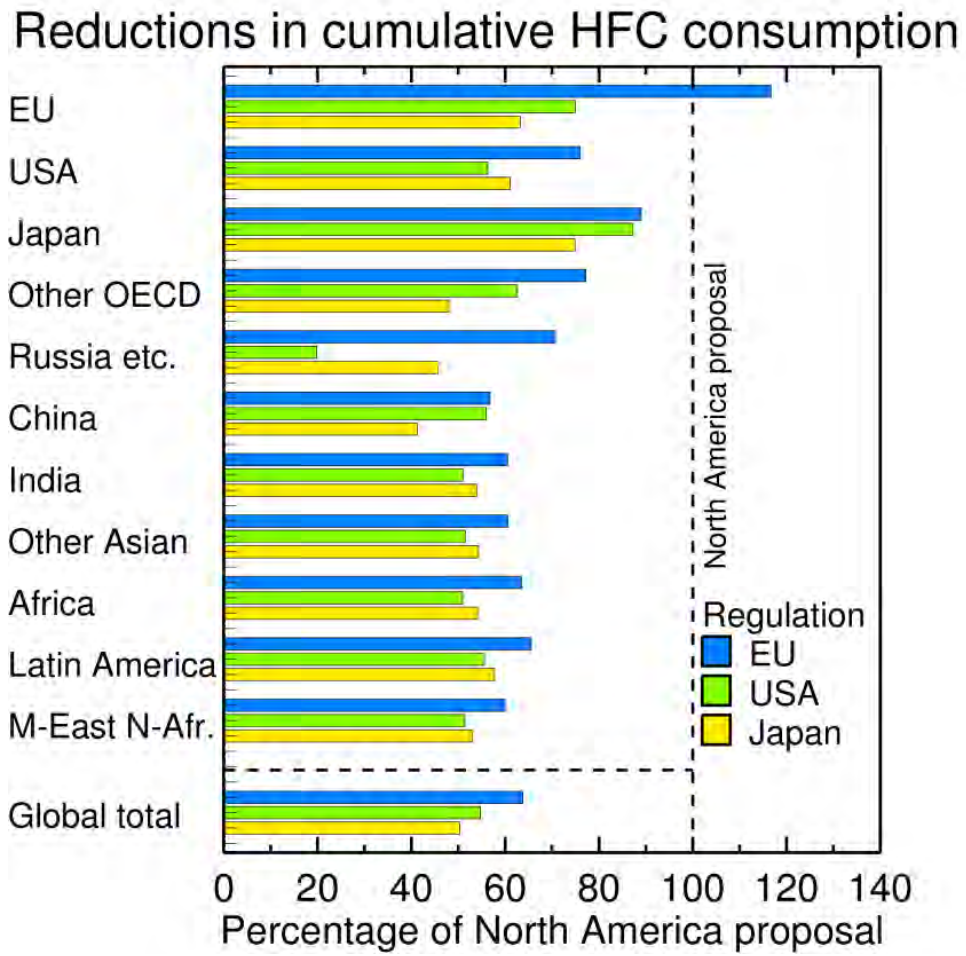
Proposals to MP met in part by regulations

Global effects of technologies

- National regulations applied globally (5 years later for A5 parties)

Reductions meet North American proposal by 50% or more for most countries by 2050

- Following current/proposed regulations alone
- Differences between countries due to differences in HFC use in sectors and regulations



Conclusions

New HFC scenarios for 11 regions, 13 sectors, 10 HFCs

- Business-as-usual emissions 4.0-5.3 $GtCO_2$-eq/yr 2050
  - 9-29% of annual increases in CO_2 emissions from 2015 to 2050
- Mainly in Asia in refrigeration and stationary AC

Regulations in EU, USA and Japan reduce national 2050 emissions by 45-75%

Montreal Protocol Amendment proposals reduce 2050 emissions by 50-90%

- Global adoption of technologies **required to meet national regulations** are sufficient meet proposals by 50% or more for most countries by 2050

Conclusions

New HFC scenarios for 11 regions, 13 sectors, 10 HFCs

- Business-as-usual emissions 4.0-5.3 $GtCO_2$-eq/yr 2050
  - 9-29% of annual increases in CO_2 emissions from 2015 to 2050
- Mainly in Asia in refrigeration and stationary AC

Regulations in EU, USA and Japan reduce national 2050 emissions by 45-75%

Montreal Protocol Amendment proposals reduce 2050 emissions by 50-90%

- Global adoption of technologies **required to meet national regulations** are sufficient meet proposals by 50% or more for most countries by 2050

Thank you