# Air Quality Co-benefits of Greenhouse Gas Mitigation

**Bert Saveyn and Rita Van Dingenen**

**European Commission, Joint Research Centre**

38th session of EB for the Convention on Long-range Transboundary Air Pollution

Geneva, 12-DEC-2018

European Commission

# Air quality co-benefits of long-term climate policies


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# EU Long-Term Strategy (LTS): Start of a process

## 7 building blocks

1.Energy efficiency

2. Renewables

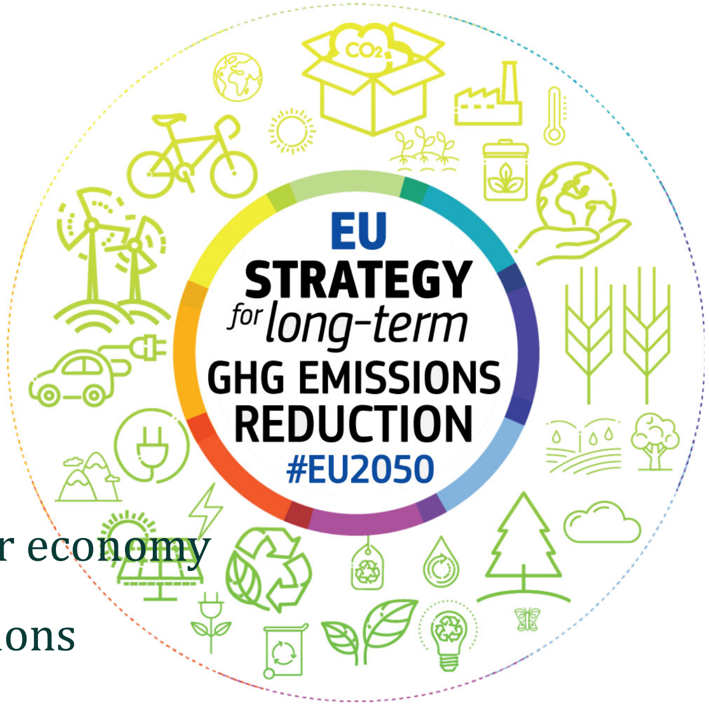
3. Clean, safe & connected mobility

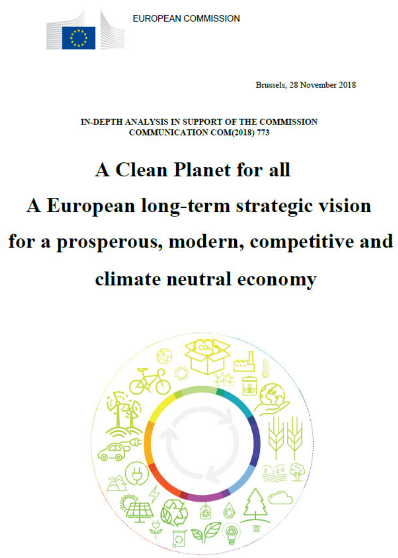
4. Competitive industry and circular economy

5. Infrastructure and inter-connections

6. Bio-economy and natural carbon sinks

7. Carbon capture and storage

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# LTS builds on broad modelling toolbox

- Long-term Strategy also includes air quality co-benefits (IIASA)

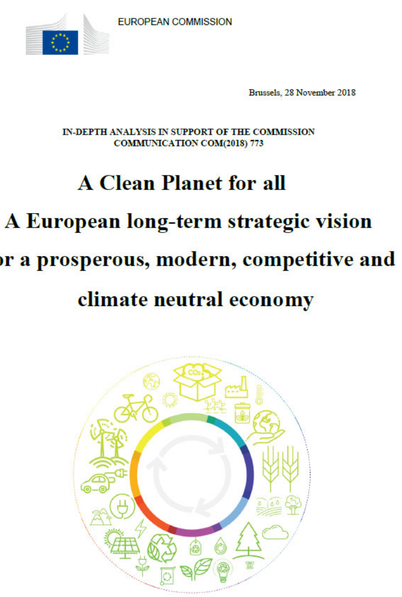

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**Table 21: Air pollution control costs and benefits in the EU compared to 2015 in 2050 (EU28).[606]**

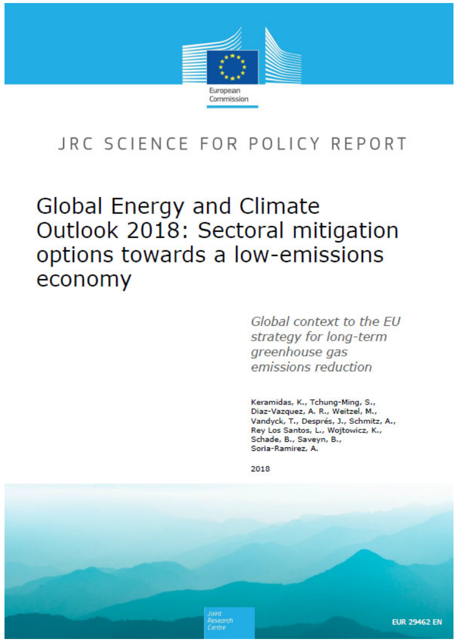
| | 2015 | Change by 2050 | | |
|---|---|---|---|---|
| | | CIRC | COMBO | 1.5LIFE |
| SO2 (kton) | 2747 | -2069 | -1975 | -2039 |
| NOX (kton) | 7224 | -5458 | -5307 | -5530 |
| PM (kton) | 1478 | -881 | -848 | -865 |
| Premature deaths ozone and PM 2.5 (1000 cases per year) | 317 | -147 | -142 | -146 |
| Health impacts (million life years lost due to PM2.5) | 5.3 | -2.5 | -2.4 | -2.5 |
| Monetary damage health PM (bn€/yr). Low estimate | 368 | -174 | -168 | -173 |
| Monetary damage health PM (bn€/yr). High estimate | 884 | -418 | -404 | -414 |
| Air pollution control costs (bn€/yr) | 80 | -32 | -36 | -45 |
| SUM pollution control costs & health damage (bn€/yr) | 448 to 964 | -206 to -450 | -204 to -440 | -218 to -459 |
| Eutrophication (Ecosystem area exceeded 1000 km2) | 1016 | -188 | -181 | -190 |
| Acidification (Ecosystem area exceeded 1000 km2) | 100 | -64 | -63 | -64 |

*Note: Estimates for monetary damage based on values per life year lost from IIASA (2017)[607] and expressed in EUR 20013. Impacts on morbidity, materials, buildings and crops are not included. Possible impacts of N2O on health are also excluded.*

*Source: GAINS*

# Global Energy and Climate Outlook

GECO 2018: Model-based Global Assessment to support the European Commission's LTS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*Global context to the EU strategy for long-term greenhouse gas emissions reduction*

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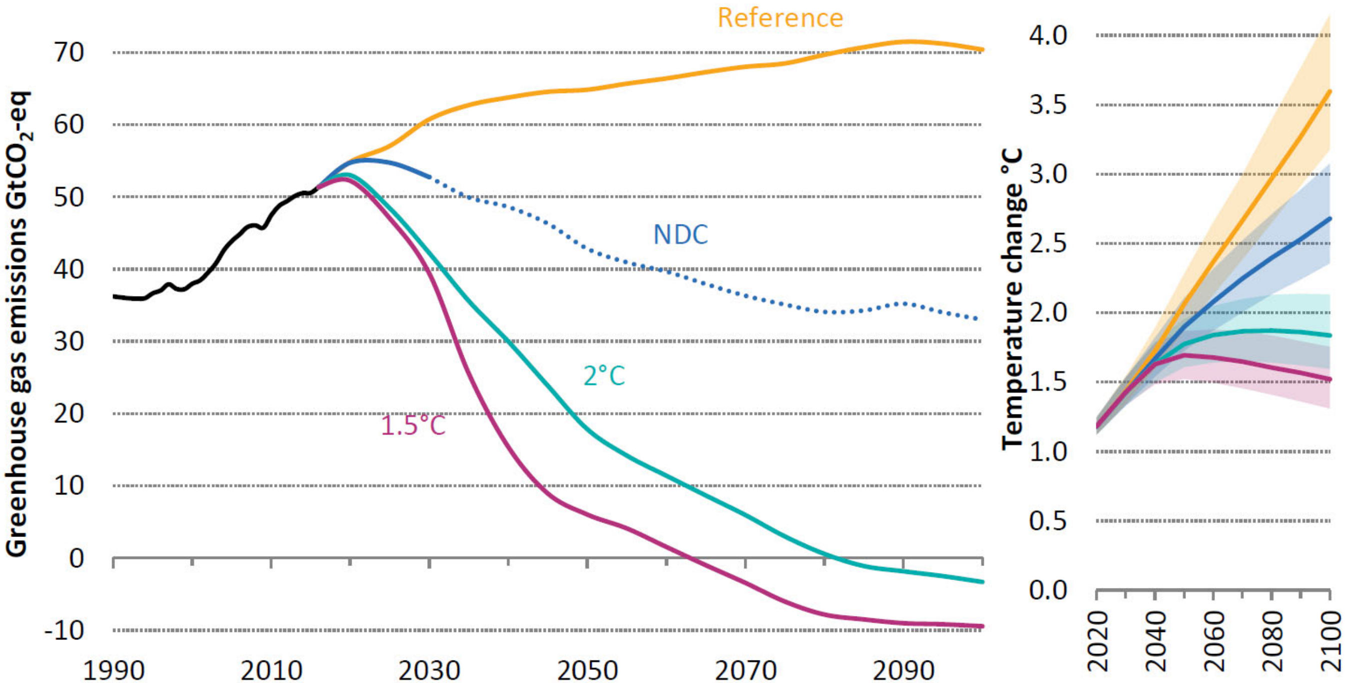


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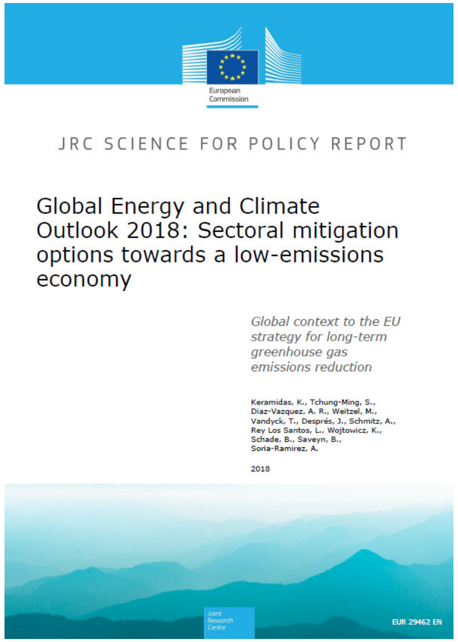
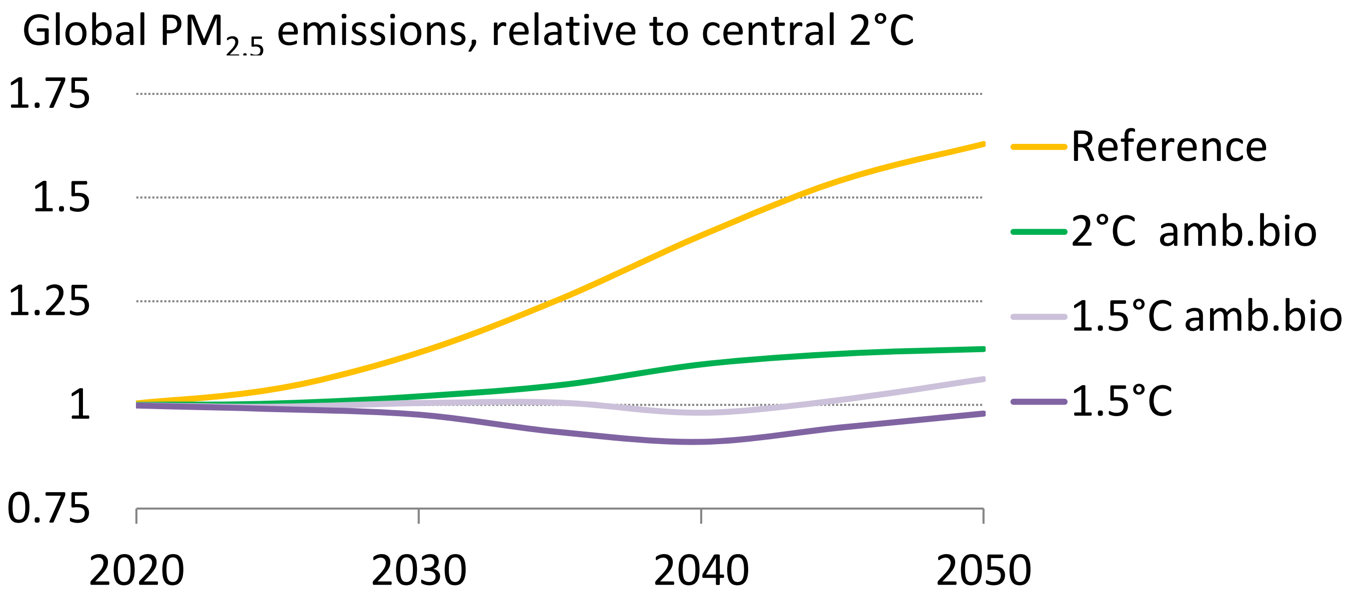
# Global Energy and Climate Outlook

- GECO 2018: Model-based assessment to support the European Commission's LTS
- Includes chapter on air pollutants

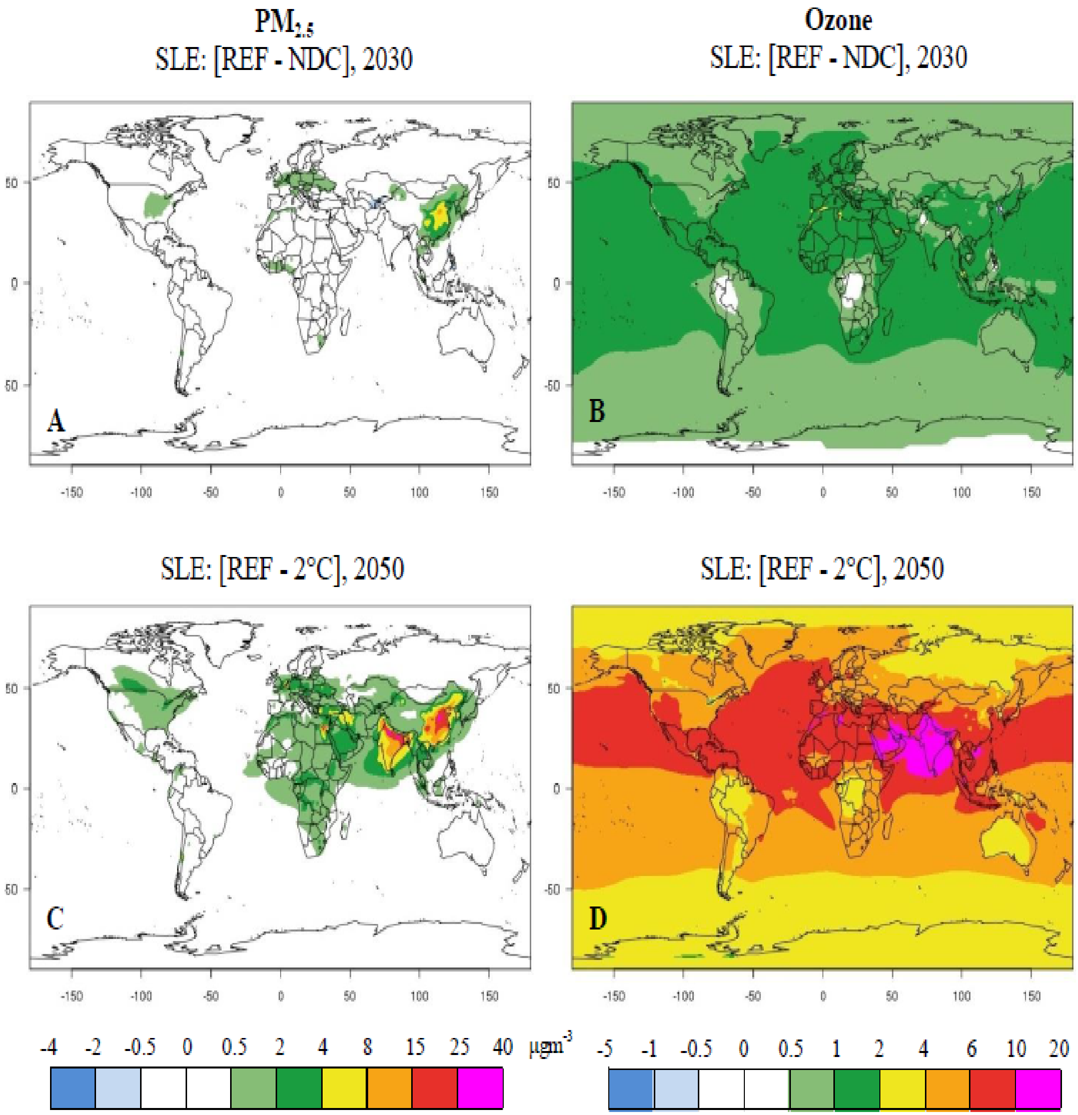


# Climate Policies can bring substantial co-benefits to Air Quality

NDC
2030

2°C
2050




Globally **100000** avoided premature deaths in **2030** with NDC

Globally **1.5 million** avoided premature deaths in **2050** with 2C scenarios

Vandyck *et al.* (2018), Nature Communications

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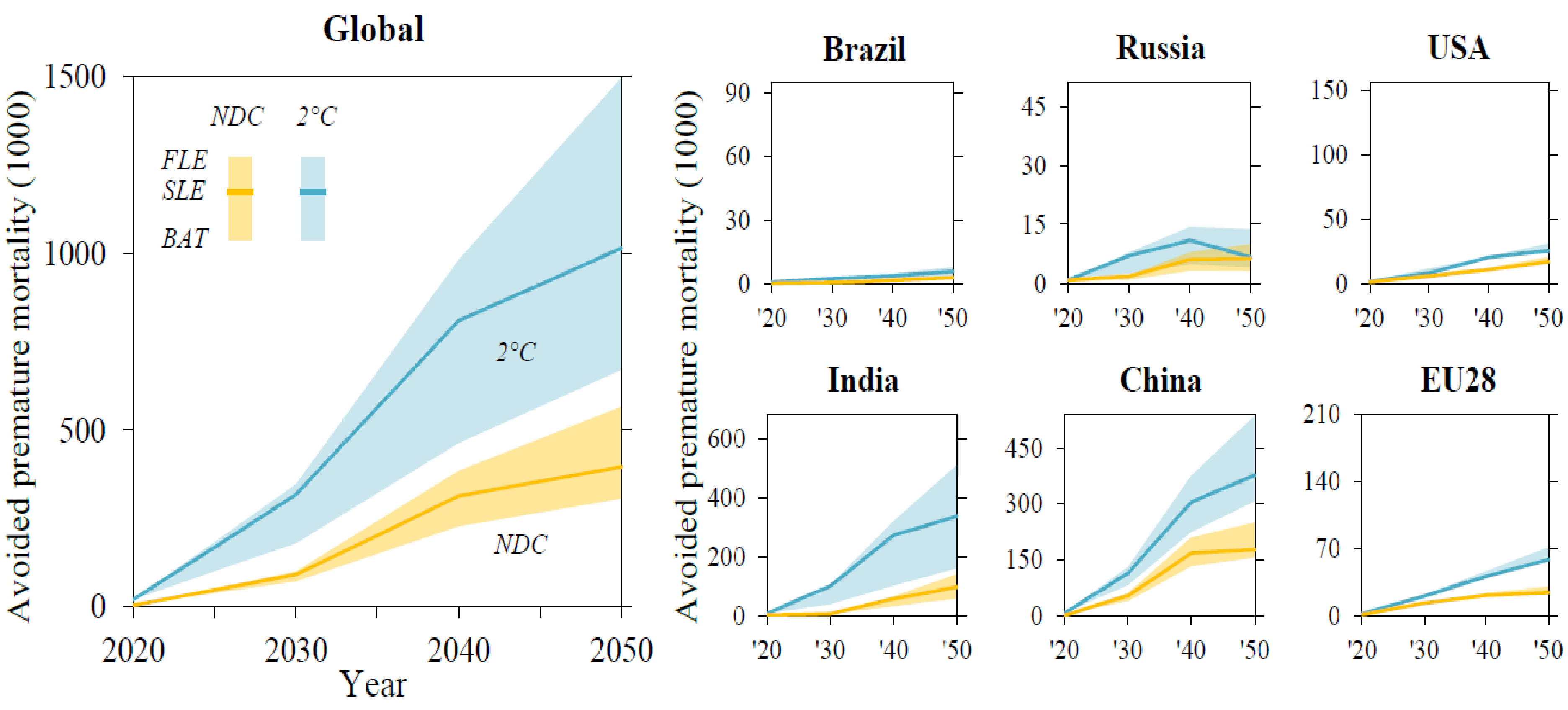
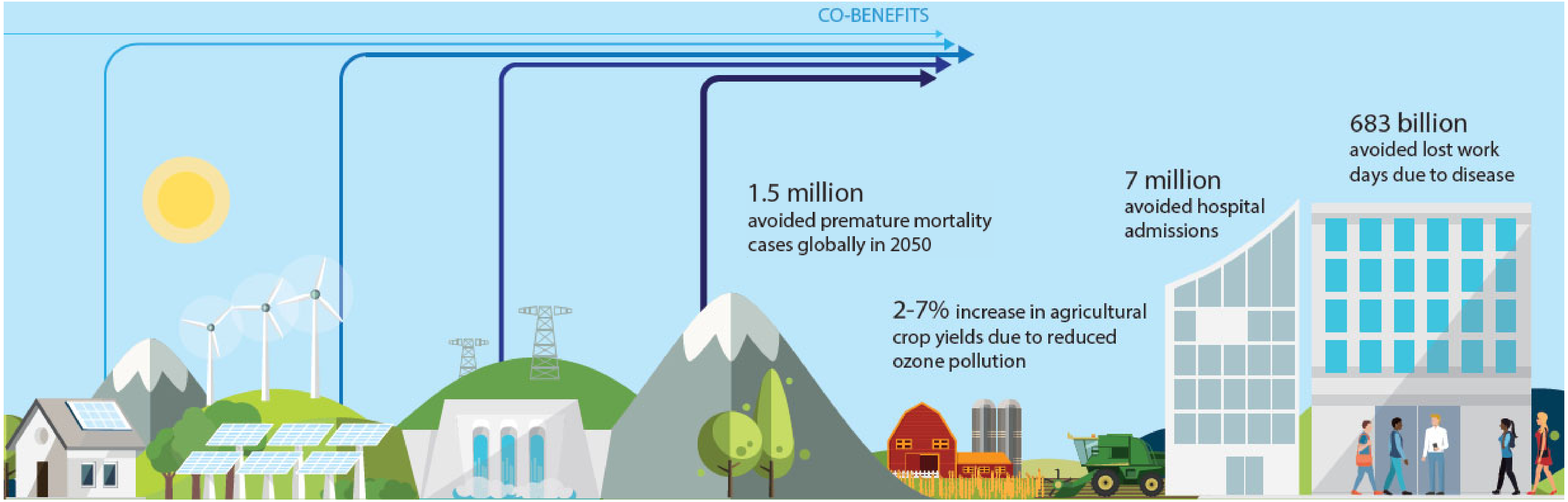
# Human health: avoided premature mortality




Vandyck et al. (2018) *Nature Communications*

# Climate Policy improves air quality and saves lives

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# Thank you

## Any questions?


Bert.Saveyn@ec.europa.eu

ec.europa.eu/jrc/en/geco


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ARTICLE

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Air quality co-benefits for human health and agriculture counterbalance costs to meet Paris Agreement pledges

Toon Vandyck[1], Kimon Keramidas[1], Alban Kitous[1], Joseph V. Spadaro[2], Rita Van Dingenen[3], Mike Holland[4] & Bert Saveyn[1]

Local air quality co-benefits can provide complementary support for ambitious climate action and can enable progress on related Sustainable Development Goals. Here we show that the transformation of the energy system implied by the emission reduction pledges brought forward in the context of the Paris Agreement on climate change (Nationally Determined Contributions or NDCs) substantially reduces local air pollution across the globe. The NDCs could avoid between 71 and 99 thousand premature deaths annually in 2030 compared to a reference case, depending on the stringency of direct air pollution controls. A more ambitious 2 °C-compatible pathway raises the number of avoided premature deaths from air pollution to 178-346 thousand annually in 2030, and up to 0.7-1.5 million in the year 2050. Air quality co-benefits on morbidity, mortality, and agriculture could globally offset the costs of climate policy. An integrated policy perspective is needed to maximise benefits for climate and health.

[1]European Commission, Joint Research Centre (JRC), 41092 Sevilla, Spain. [2]Spadaro Environmental Research Consultants (SERC), 19142 Philadelphia, USA. [3]European Commission, Joint Research Centre (JRC), 21027 Ispra, Italy. [4]Ecometrics Research and Consulting (EMRC), RG8 7PW Reading, UK. Correspondence and requests for materials should be addressed to T.V. (email: toon.vandyck@ec.europa.eu)

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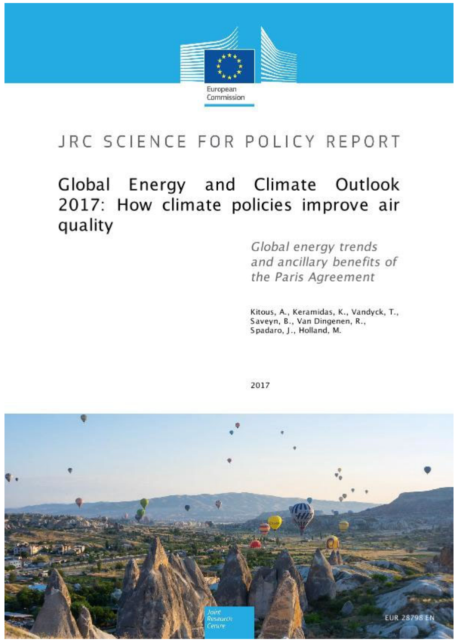

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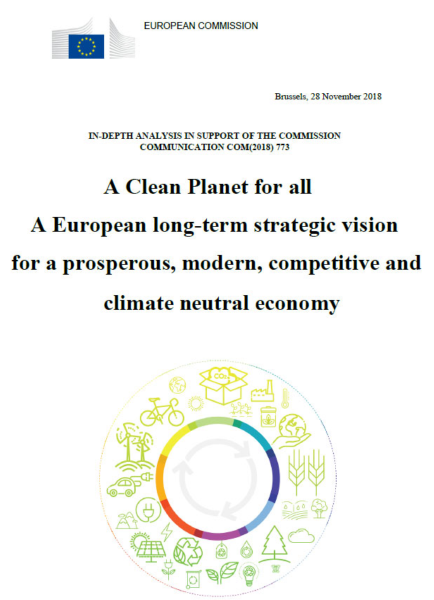
Global Energy and Climate Outlook 2017: How climate policies improve air quality

*Global energy trends and ancillary benefits of the Paris Agreement*

Kitous, A., Keramidas, K., Vandyck, T., Saveyn, B., Van Dingenen, R., Spadaro, J., Holland, M.

2017



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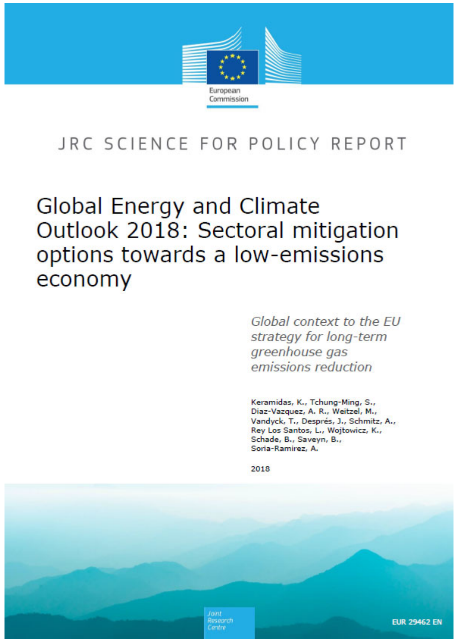

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# Global trends of methane emissions and their impacts on ozone concentrations

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# Context

- Methane ($CH_4$) is an important greenhouse gas and precursor for troposheric ozone ($O_3$) at the hemispheric/global scale
- 50 to 60% of $CH_4$ emissions are of anthropogenic origin
- After a leveling trend in 1998 – 2008, methane concentrations in the atmosphere are increasing again.
- $CH_4$ is included in EU climate long-term strategy but not in NECD – however Commission formulated intention to review CH4 emissions in context of assessing options to further reduce ozone concentrations in the EU
- CLRTAP long term strategy: priority $PM_{2.5}$, $O_3$, SLCPs

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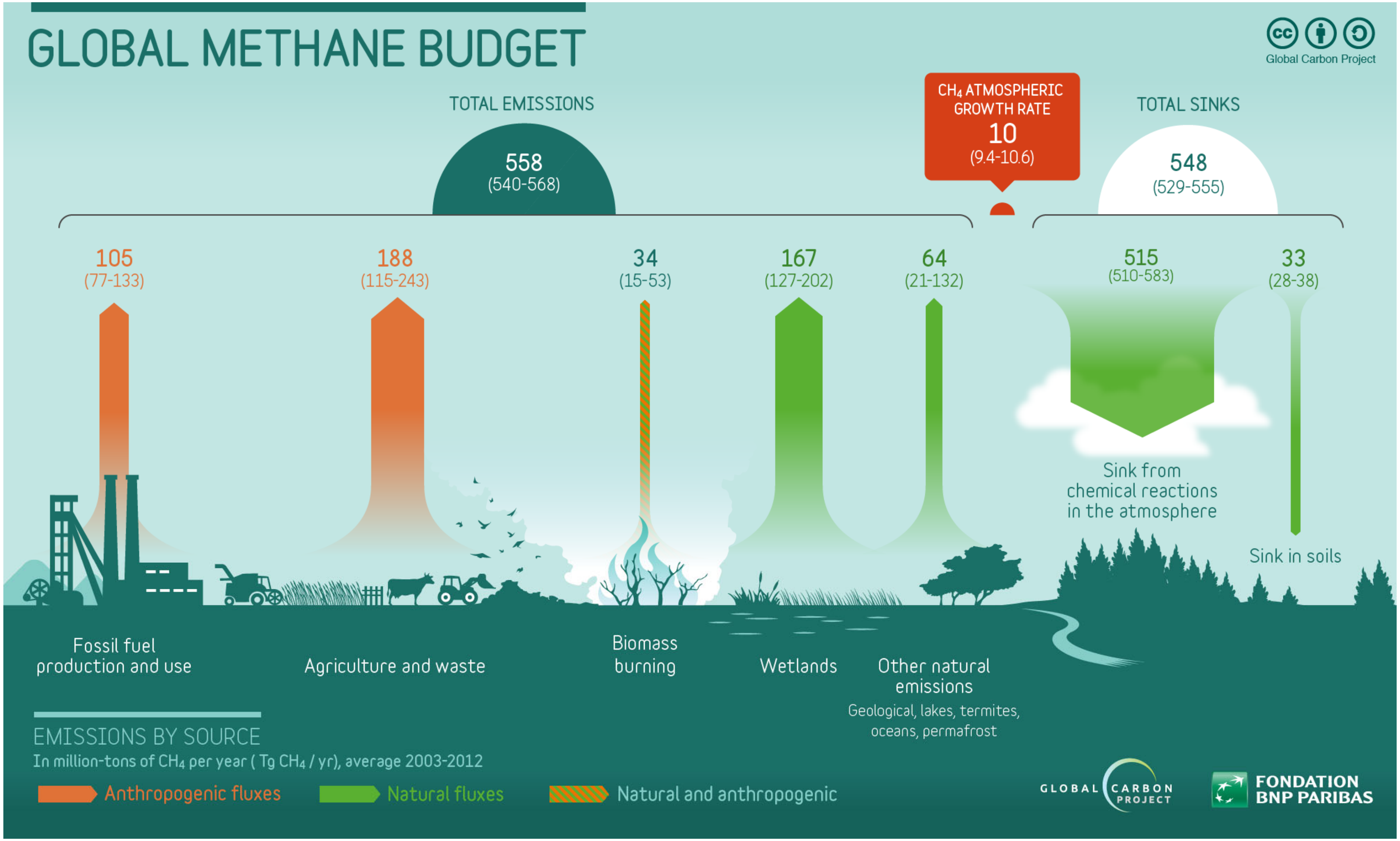
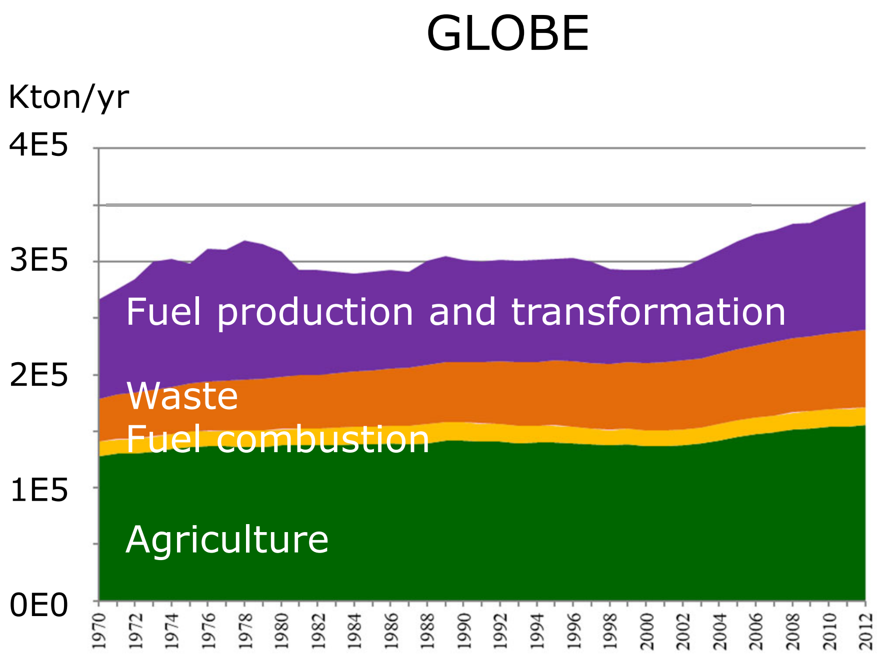
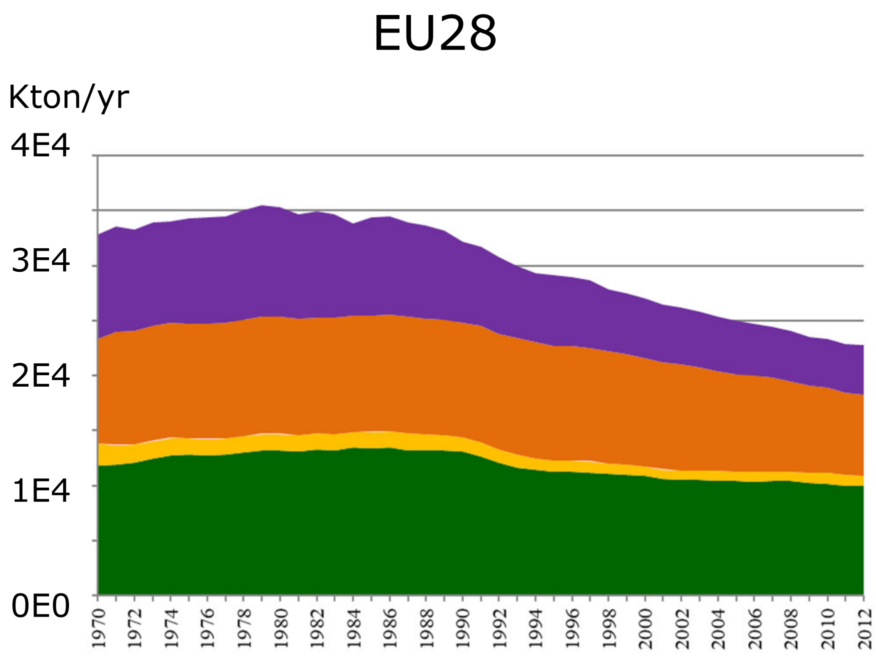
# Global Methane Budget 2003 – 2012 (Tg/yr)



# Anthropogenic methane emission trends by sector 1970 – 2012




Source: JRC EDGAR v4.3.2
http://edgar.jrc.ec.europa.eu

EDGAR EMISSION DATABASE FOR GLOBAL ATMOSPHERIC RESEARCH

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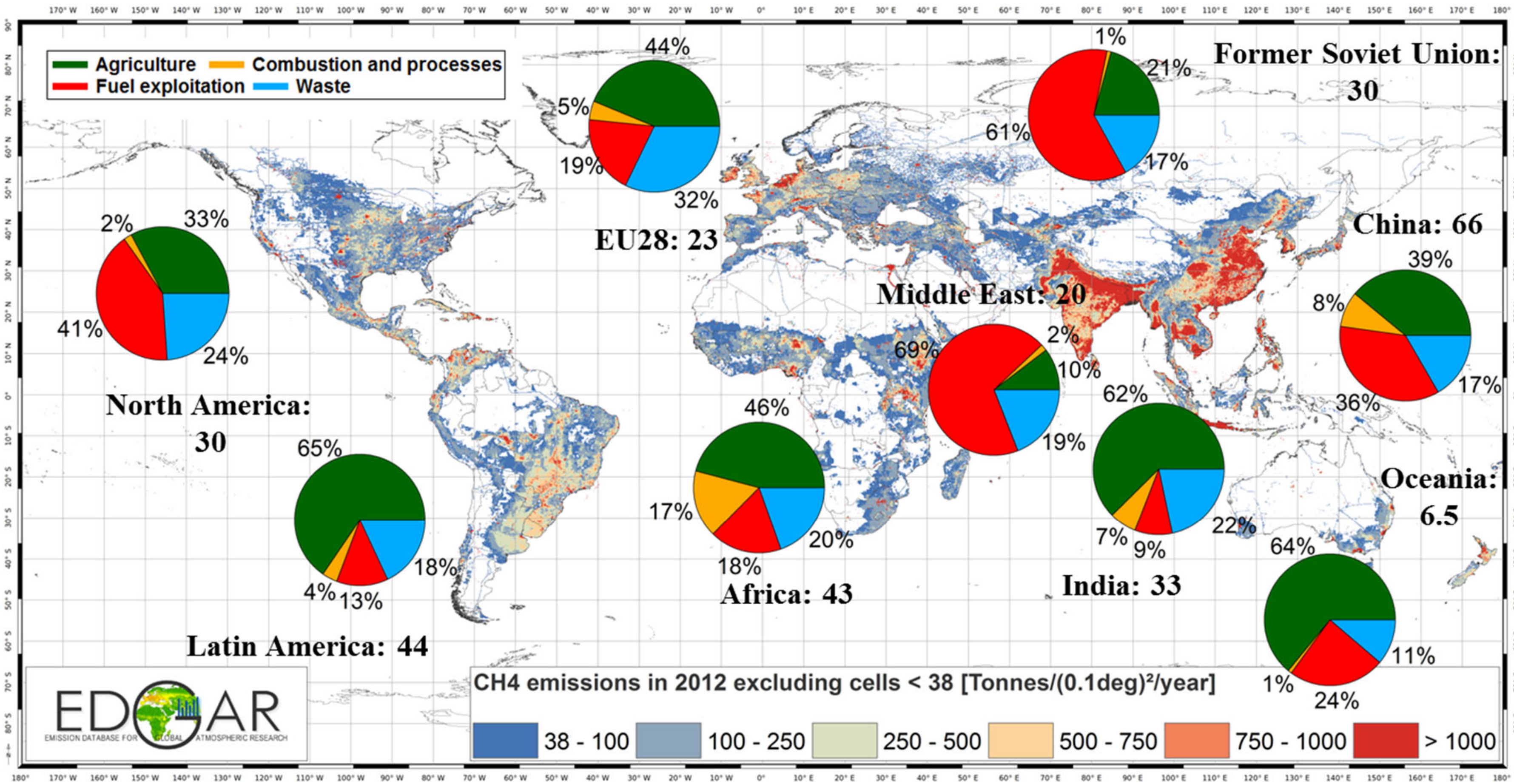
# Methane yr 2012 emission by sector, by region

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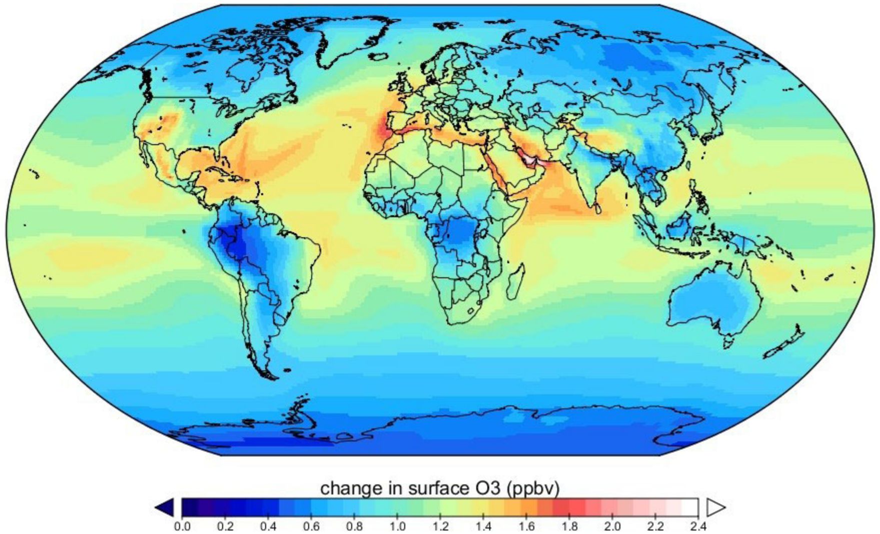
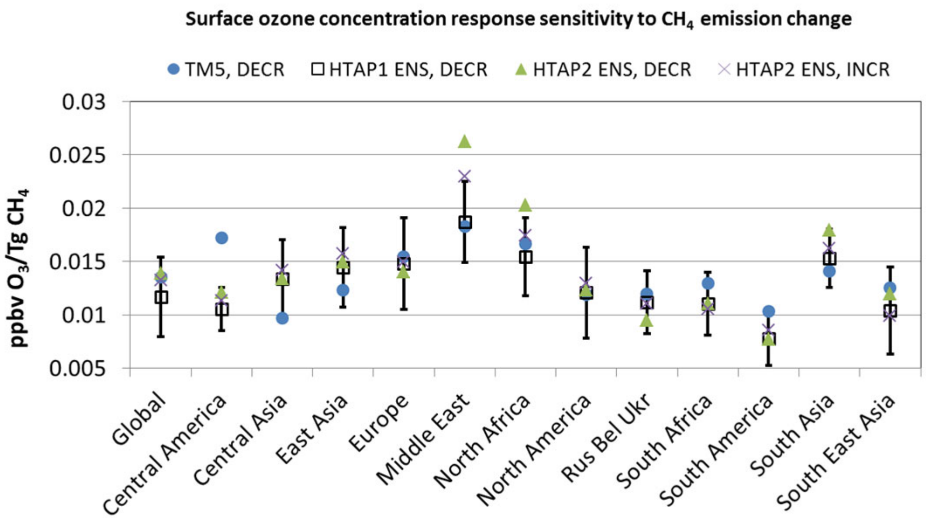
# Ozone response to (uniform) $CH_4$ concentration reduction

- Due to 12 yr $CH_4$ lifetime: Local long-term $O_3$ response is largely **independent** of location of $CH_4$ emission change
- Long-term $O_3$ response depends on local $NO_x$ and NMVOC emissions




Source: JRC, TM5 model




Source: JRC, TM5 model, HTAP1 and HTAP2 models (Turnock et al., 2018)

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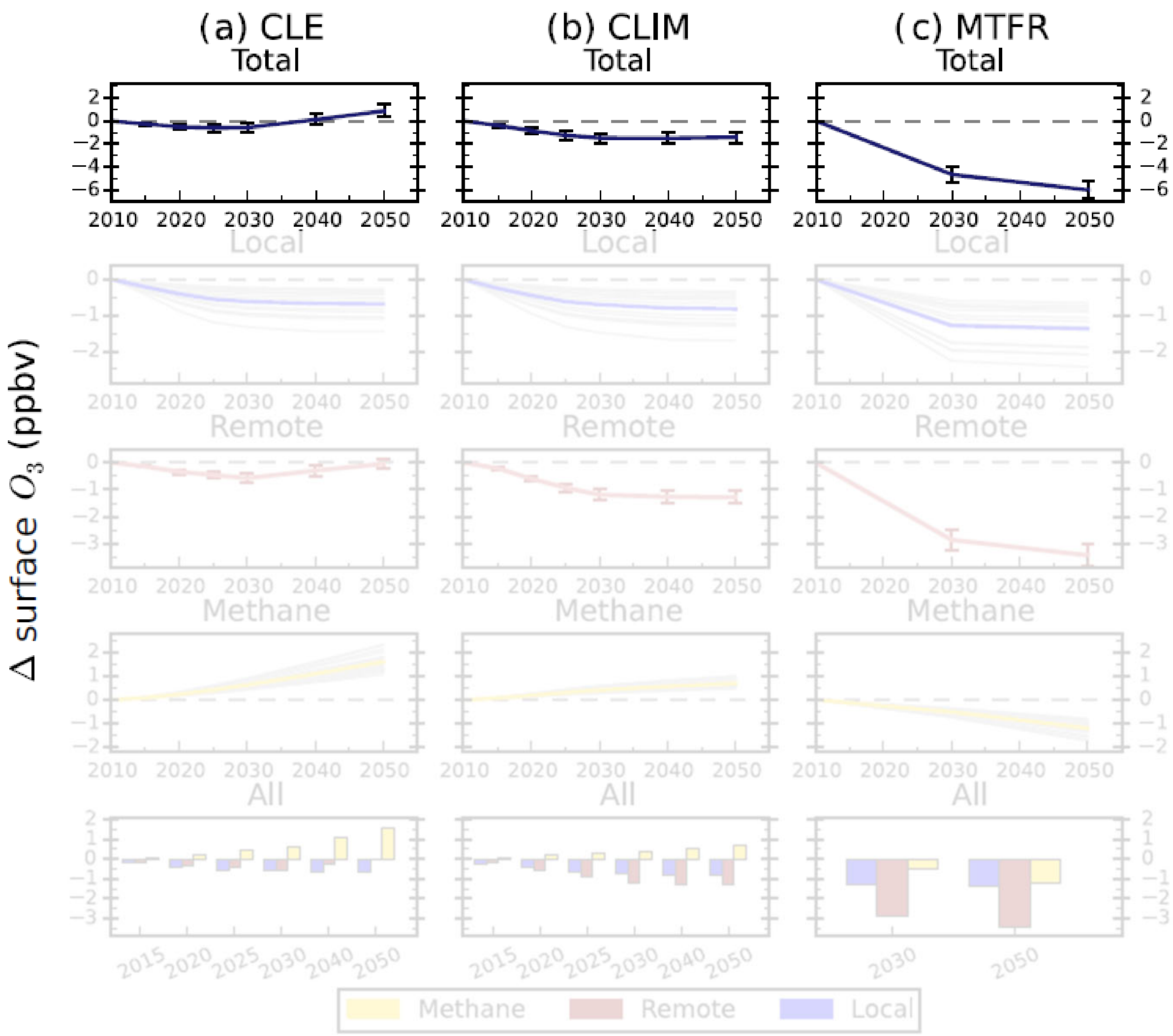
# How much does $CH_4$ contribute to $O_3$ in Europe? (HTAP2 modeling results)




Source: Turnock et al., Atm. Chem. Phys, 2018

Local precursors control

Contribution from long-range ozone transport

Methane contribution

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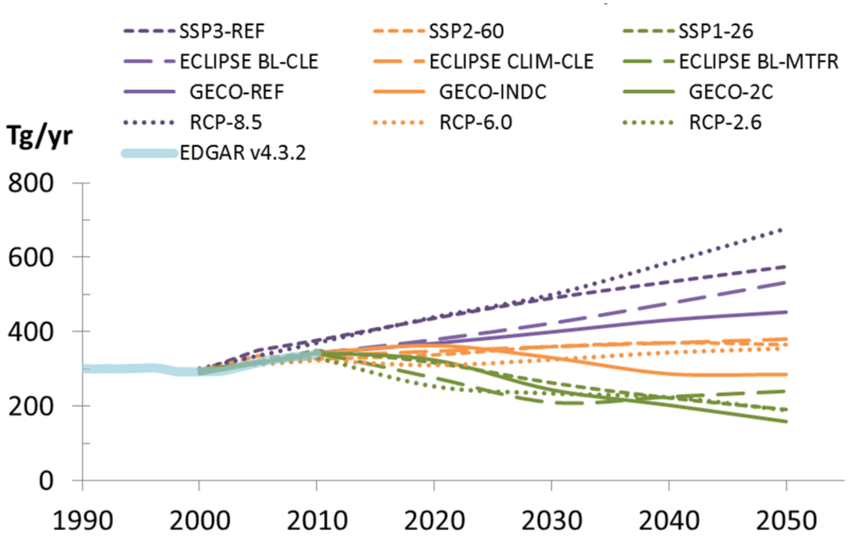
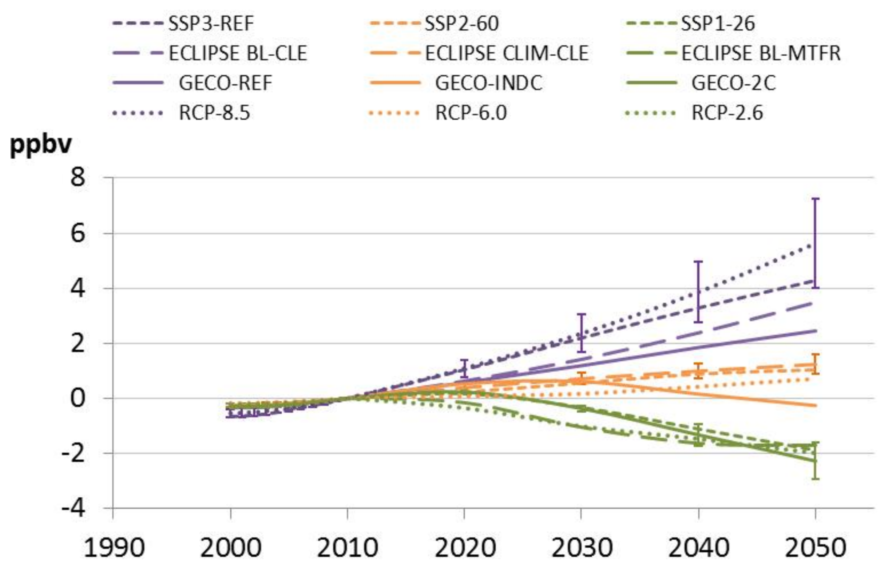
# Future $CH_4$ emission scenarios and their impacts on $O_3$ and health

Past and projected global $CH_4$ emissions → Ozone trends in Europe (exposure metric)

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# Regional potential health benefit (mitigation versus non-mitigation)

| Mortality difference (thousands) | Global | Europe | North America | Middle East | Russia Belarus & Ukraine | Central Asia | East Asia | South Asia | South East Asia | North Africa | Sub-Sahara Africa | South America | Central America |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RCP** | 125 | 10.7 | 5.2 | 2.8 | 0.8 | 9.4 | 13.9 | 52 | 17 | 2.1 | 6.3 | 2.6 | 1.9 |
| **SSP** | 102 | 8.6 | 4.2 | 2.3 | 0.6 | 7.6 | 11.3 | 43 | 14 | 1.7 | 5.2 | 2.1 | 1.5 |
| **ECLIPSE** | 86 | 7.2 | 3.5 | 1.9 | 0.5 | 6.4 | 9.5 | 36 | 12 | 1.5 | 4.4 | 1.8 | 1.3 |
| **GECO2017** | 79 | 6.4 | 3.1 | 1.8 | 0.5 | 5.9 | 8.8 | 33 | 11 | 1.4 | 4.2 | 1.7 | 1.2 |

Year 2050 $O_3$ differences in mortality between highest and lowest emission scenario in each scenario family for HTAP2 world regions, relative to year 2010.

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# Key messages:

- Unabated, global anthropogenic $CH_4$ emissions could increase by 35 to 100% by 2050 for a range of pessimistic scenarios causing 40,000 (+12%) to 90,000 (+26%) more $O_3$ premature deaths compared to present-day $O_3$ levels.

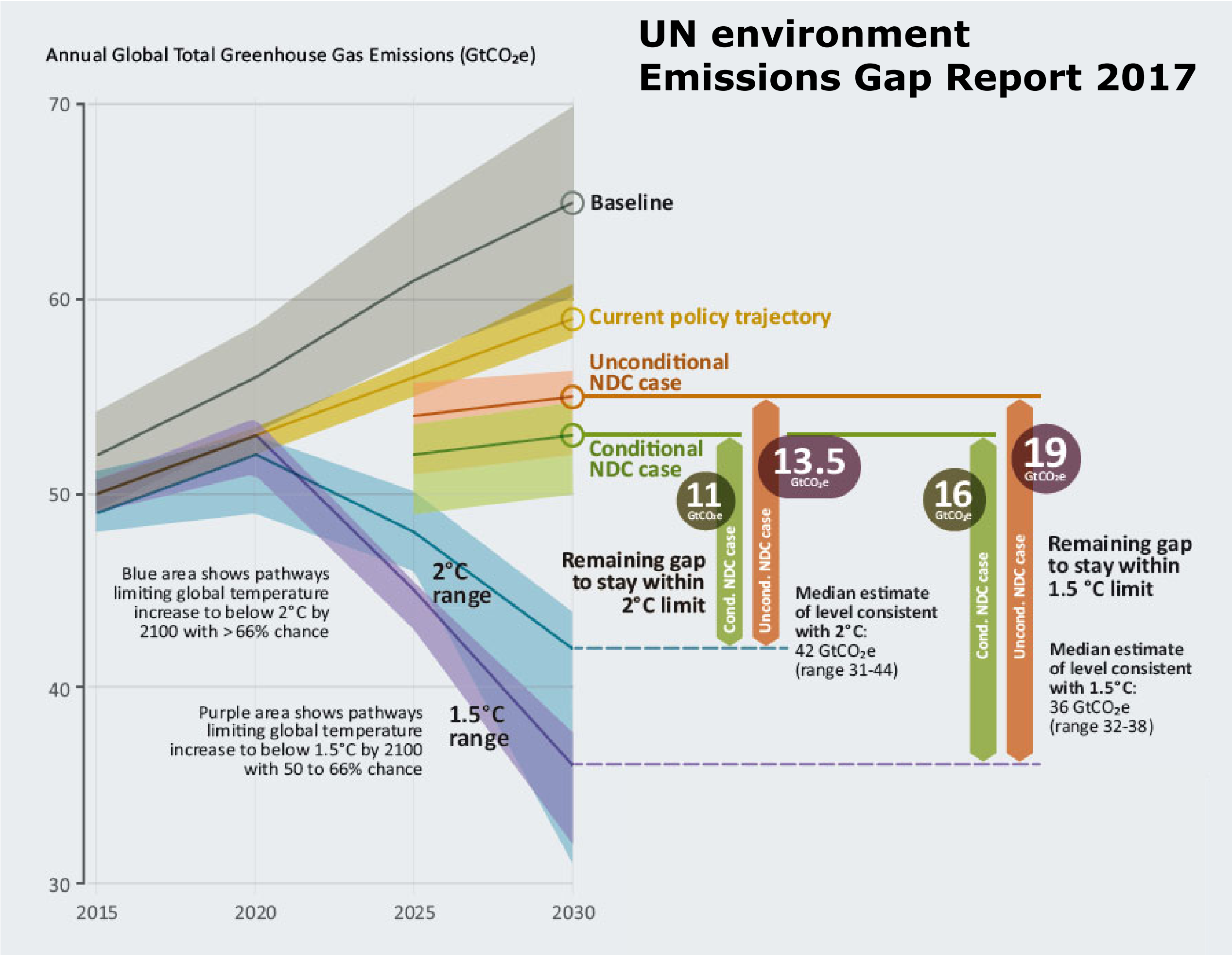
- By contrast, optimistic sustainability scenarios project $CH_4$ emission reductions of up to 50% by 2050 saving worldwide 30,000 (-9%) to 40,000 (-12%) lives.

- Except for most stringent mitigation scenarios, the relative contribution of $CH_4$ to surface $O_3$ (and its environmental impacts) will increase in the next decades

- Sustainable scenarios assume structural changes in the energy, waste and agricultural sectors, together with the implementation of all currently available emission abatement technologies.
  A number of the methane emission reduction technologies may have negative, zero or small positive costs, making them attractive targets for policies.

- The benefits of $CH_4$ of emission reductions are globally distributed, therefore global mitigation strategies are most effective in reaching substantial health benefits within and outside individual world regions

# Climate benefit




**Stringent** $CH_4$ scenarios:

**2.1** to **3.4** Gt $CO_{2eq}$ additional reduction compared to NDCs in 2030 (i.e. 16 to 31% of 2°C emission gap; 11 to 21% of 1.5° emission gap)

# Thank you!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Global trends of methane emissions and their impacts on ozone concentrations

Van Dingenen, R., Crippa, M., Maenhout, G., Guizzardi, D., Dentener, F.

2018

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**Report nr: EUR 29394 EN**

**rita.van-dingenen@ec.europa.eu**

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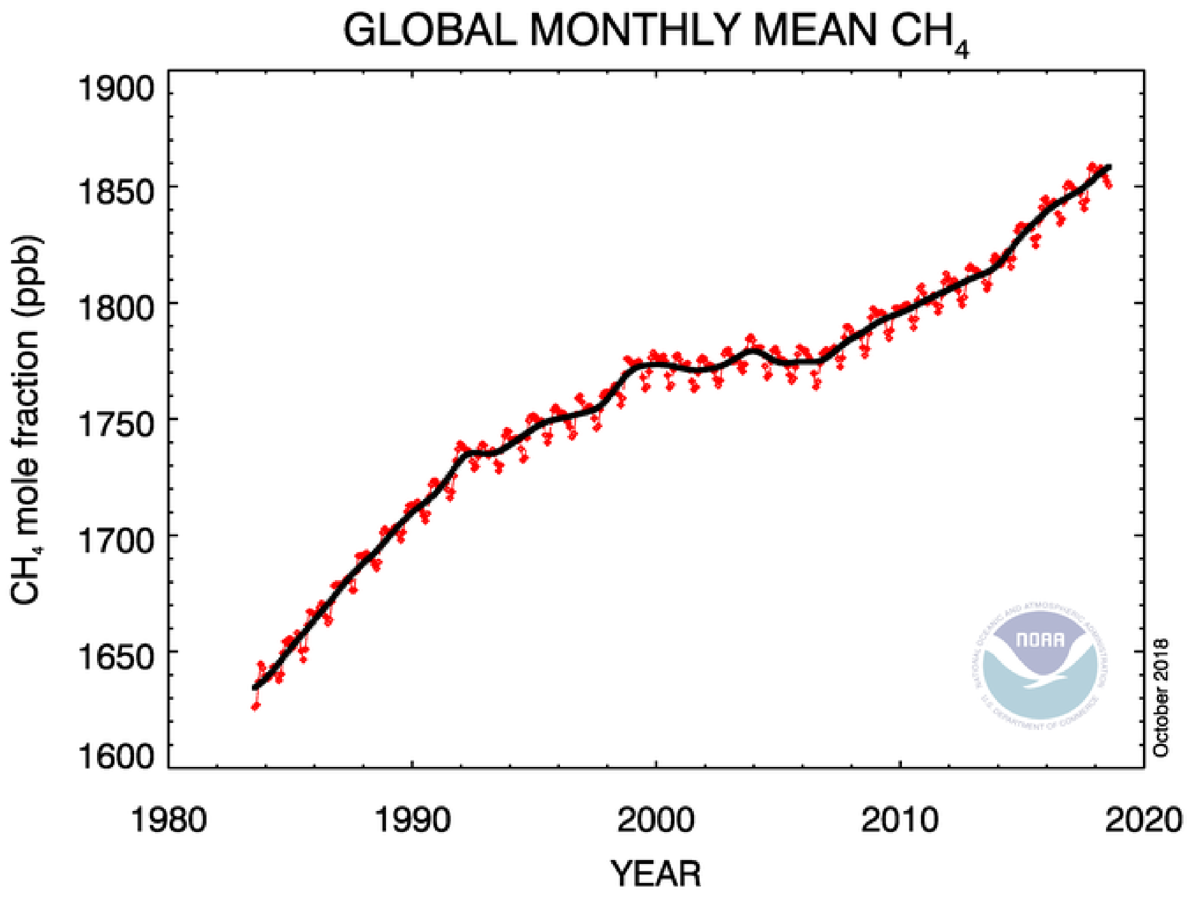
# Methane: observed global concentration trend




After plateau 1998 – 2008 methane concentration increasing again

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# $CH_4$ mitigation potential

| Sector | Control measure |
|---|---|
| **Livestock** | Enteric fermentation: diet changes, vaccination |
| | Improving animal health and productivity: genetic improvement, diet changes |
| | Manure management: anaerobic digestion, direct injection in soils of liquid manure. |
| **Rice cultivation** | Mixed: interrupted flooding and alternate wetting and drying, alternative hybrids, sulfate amendments |
| **Agricultural waste burning** | Ban on burning. |
| **Solid waste** | Maximum separation and treatment, no landfill of biodegradable waste |
| **Wastewater** | Extended treatment with gas recovery and utilization |
| **Coal mining** | Pre-mining degasification |
| | Ventilation air oxidizer with improved ventilation systems |
| **Conventional natural gas production** | Recovery and utilization of vented associated gas |
| | Good practice: reduced unintended leakage |
| **Unconventional natural gas production** | Good practice: reduced unintended leakage |
| **Long-distance gas transmission in pipelines** | Leakage control, especially at the pumping units |
| **Gas distribution networks** | Leakage control and replacement of grey cast iron networks |
| **Oil production and refinery** | Recovery and utilization of vented associated gas |
| | Good practice: reduced unintended leakage |

Technically feasible control measures for $CH_4$ emissions in a number of key-sectors.
Source: Höglund-Isaksson et al. (2012; 2015)

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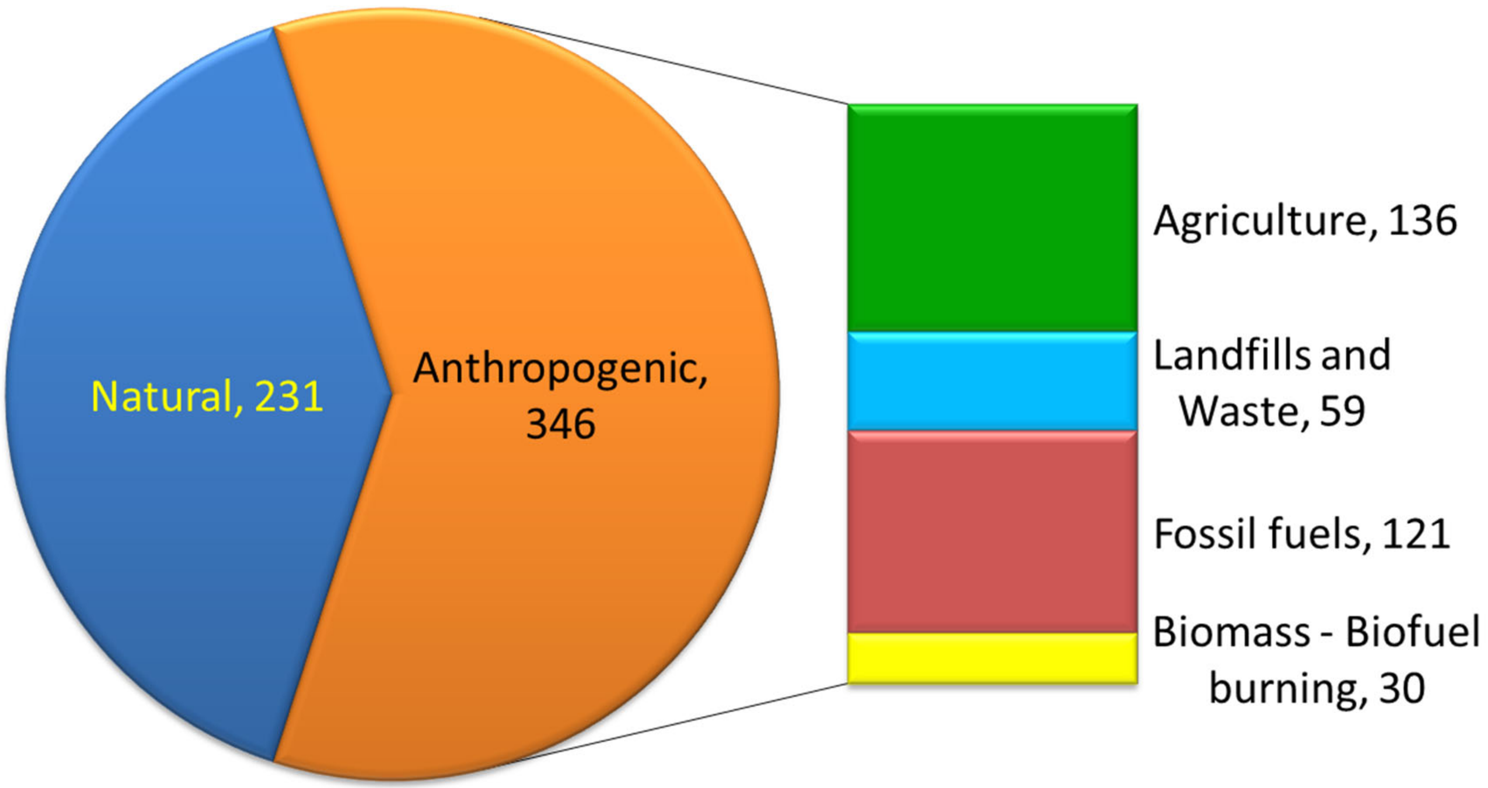
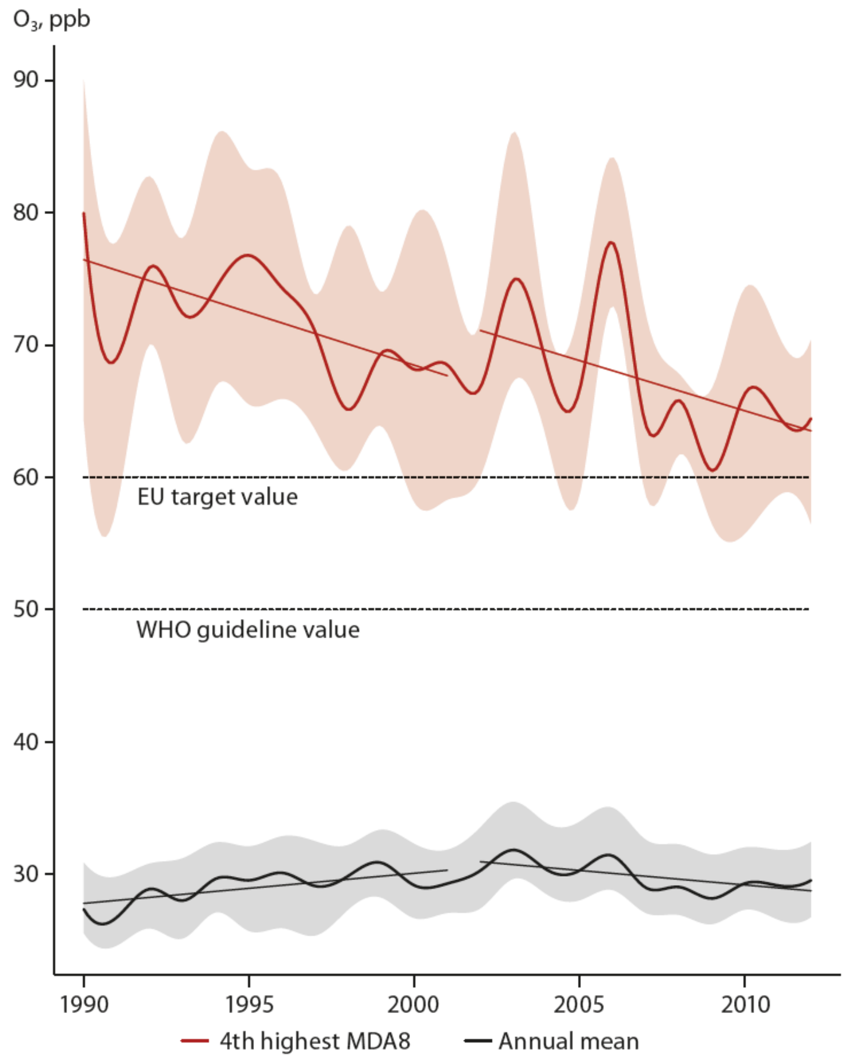
# Global Natural vs Anthropogenic CH4 emissions



# Ozone trends in Europe (EMEP)




Ozone **peak** concentrations declining

Annual **mean** values increased in 1990 – 2000, stabilized afterwards

# $O_3$ health benefit from $CH_4$ mitigation