

# DEVELOPMENT AND CLIMATE CHANGE: THE IMPORTANCE OF A METHANE REDUCTION POLICY FOR THE 21<sup>ST</sup> CENTURY

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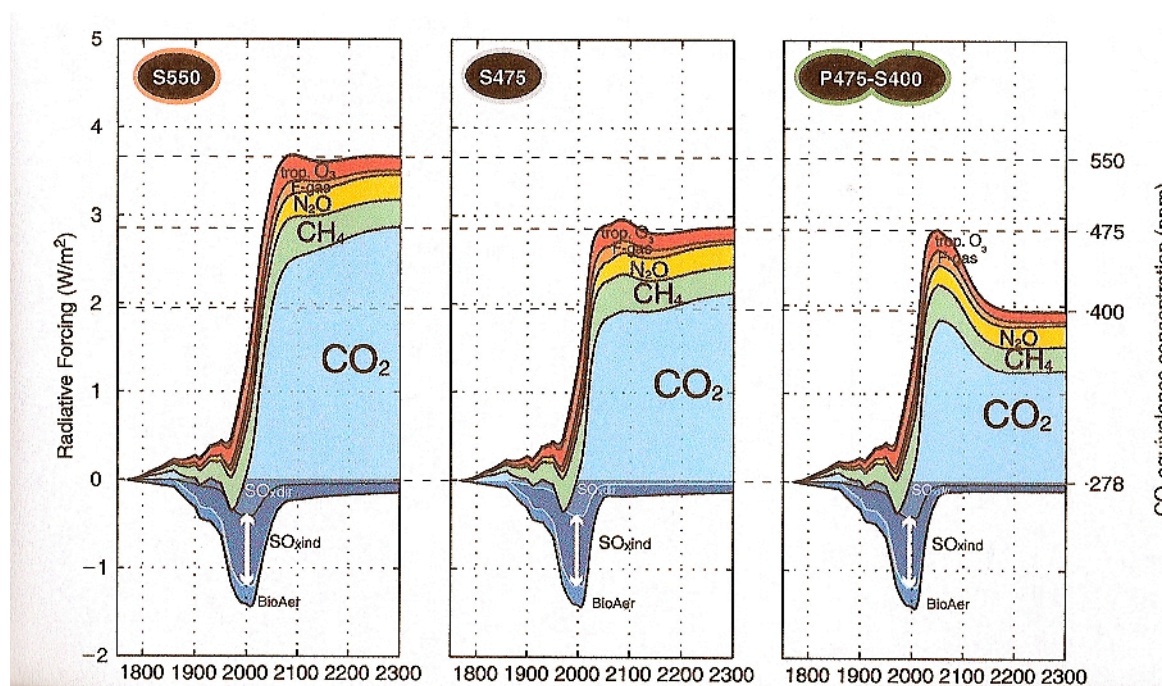
## I. THE CLIMATE RISK

No-one any longer calls into question the latest IPCC report which emphasises the urgent need to take action to avoid the worst in terms of climate change. IPCC's Working Group II firstly shows that if the global average temperature in the atmosphere rises 2.5-3°C above preindustrial levels, there is a strong risk that irreversible impacts (melting of permafrost, highly reduced role of forest cover and oceans as carbon sinks), and thus unavoidable climate change, will occur. For this reason, regions such as Europe have set a target of a maximum 2°C global temperature increase.

But what does such a target mean in terms of greenhouse gas (GHG) concentrations and emissions?

This question can be answered in part by comparing many scenarios defined by the IPCC. This exercise shows that the only reasonable chance of statistically reaching the "2°C" constraint is if humanity manages to stabilise concentrations of all GHGs between 400 and 450 ppmv CO<sub>2</sub>eq<sup>1</sup> in the long term. However, the analysis also highlights that if GHG concentrations go significantly beyond this target threshold at any time in the intermediate period between 2020 and 2100 (above 475 to 500 ppmv), it is likely that it would become impossible to reach the target at all.

The figure below illustrates this point. From the scenarios depicted in the left-hand and central figures, it can be inferred that it is highly likely, if not certain, that the rise in global average surface temperature will be greater than 2°C. It is highly likely that, in the scenarios depicted in the right-hand figure, culminating at 475 ppmv CO<sub>2</sub>eq during this century (or at close to 3 Watts/m<sup>2</sup> of radiative forcing<sup>2</sup>), falling to 400 ppmv CO<sub>2</sub>eq (or 2 W/m<sup>2</sup>) beyond 2100, a rise of more than 2°C will be avoided.



**Figure 1** : Contribution of the different radiative forcing components to net radiative forcing for paths leading to stabilisation at 550 to 400 ppmv CO<sub>2</sub>eq. The upper boundary of the curves shows anthropogenic radiative forcing. The net cooling effect caused by direct and indirect effects of various aerosols (SO<sub>x</sub> and biomass) is indicated by the negative boundary of the curves. The arrows indicate the high level of uncertainty concerning forcing due to SO<sub>x</sub>.

Source : Malte Meinshausen – Swiss Federal Institute of Technology (ETH Zurich).

<sup>1</sup> CO<sub>2</sub> concentrations with the same climate impact as the concentrations of a given set of GHGs in a given year.

<sup>2</sup> Radiative forcing (in W/m<sup>2</sup>) expresses the variation in surface irradiance due to the different GHGs.

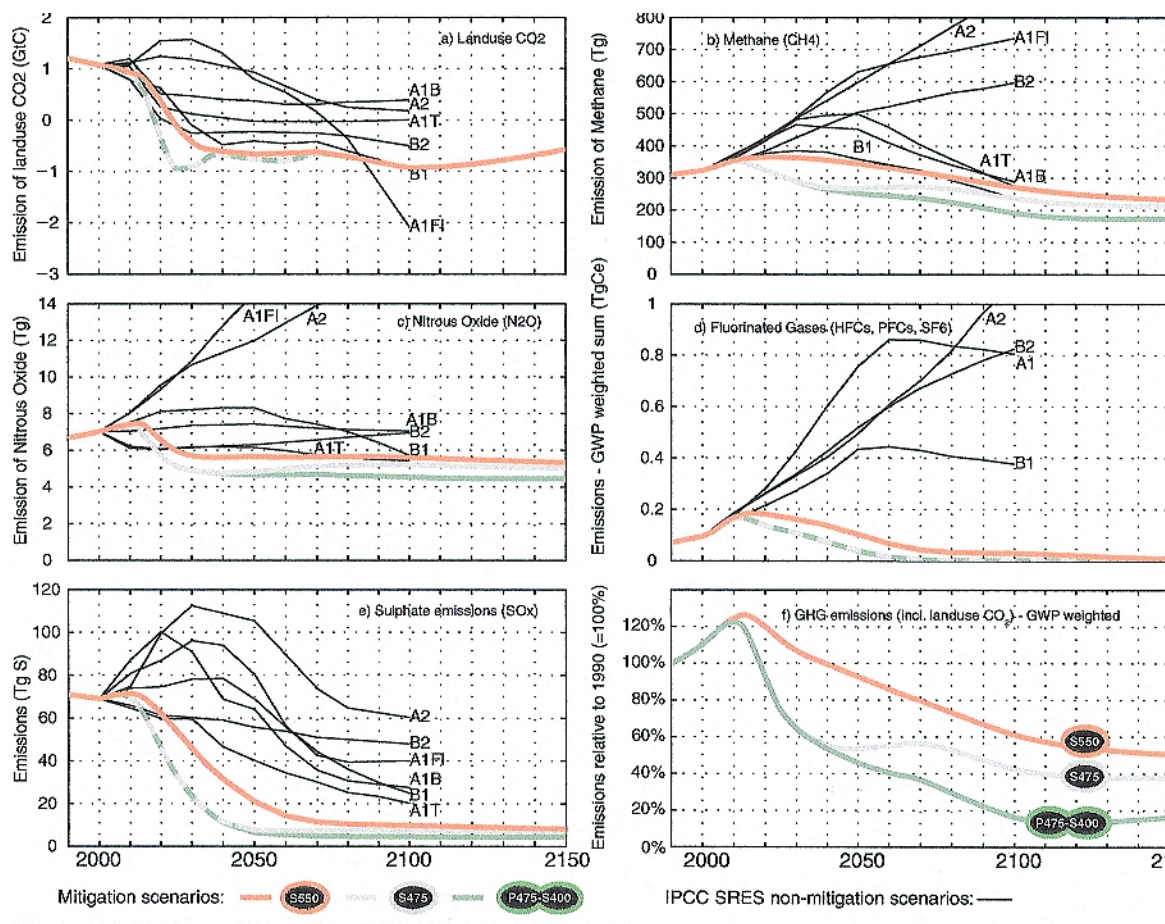
## II. WHAT IS THE SITUATION TODAY?

In its latest report, IPCC's Working Group 1 gives quite specific indications of the changes in GHG concentrations (in ppmv CO<sub>2</sub>eq) and radiative forcings in recent decades. In 2005, CO<sub>2</sub> concentrations reached 379 ppmv, while additional radiative forcing was 1.66W/m<sup>2</sup> relative to the preindustrial period. The contribution of other GHGs to additional radiative forcing was 1W/m<sup>2</sup> and the negative effect of aerosols was around 0.7W/m<sup>2</sup>. This therefore gives a total additional radiative forcing of about 1.6 W/m<sup>2</sup> (with a wide margin of error, given the uncertainty surrounding aerosols).

Since the year 2000, however, global GHG emissions as a whole, calculated in accordance with the rules of equivalence defined by the IPCC (1kg CH<sub>4</sub> is equivalent to 21 kg CO<sub>2</sub>, 1kg N<sub>2</sub>O is equivalent to 310 kg CO<sub>2</sub>), have increased at a rate of 3% per year and this upward trend shows no signs of reversing. Clearly, under these conditions, it is likely that the maximum acceptable concentration (and additional radiative forcing of around 3W/m<sup>2</sup>) will be exceeded well before 2050.

Consequently, the climate question will arise in a far shorter term than policy-makers generally imagine, as figure 2 below shows. In particular, the last graph (bottom right), which summarises the preceding ones, shows the slope of the global emissions curve (in t CO<sub>2</sub> eq) that needs to be followed in order to avoid uncontrollable impacts of the Earth's climate.

**Figure 2 : GHG emission trends for the different paths under the "550", "475" and "400" ppmv CO<sub>2</sub> eq scenarios shown in figure 1.**



Source : Malte Meinshausen – Swiss Federal Institute of Technology (ETH Zurich).

The above figures highlight the need to reach a turning point in the extremely short term followed by a steep decline of around 40% of global emissions by 2030 (in t CO<sub>2</sub> eq) compared to 1990 levels. Yet, today, GHG emissions are rising at a considerably faster rate than indicated by the 475-400ppm curve<sup>3</sup>.

These data show the scale of the issue in terms of the short-term **reduction dynamics**.

<sup>3</sup> GHG emissions increased by almost 24% between 1990 and 2004.

### III. A COMPARISON OF CO<sub>2</sub>-CH<sub>4</sub> EMISSION REDUCTION PROGRAMMES

Global GHG emissions in 1990 and in 2004 (expressed in t CO<sub>2</sub> eq, in accordance with the rules currently in force under the Climate Convention<sup>4</sup>), were as follows:

Emissions* in Gt CO <sub>2</sub> eq	1990	2004	Difference (2004-1990)
CO <sub>2</sub>	29	37.6	+8.6
CH <sub>4</sub>	6.8	7.5	+0.7
N <sub>2</sub> O	3.4	3.7	+0.3
CFC	0.2	0.4	+0.2
<b>Total</b>	<b>39.4</b>	<b>49.2</b>	<b>+9.8</b>

Looking at these data, it is clear why CO<sub>2</sub> emissions more or less hold policy-makers' full attention. CO<sub>2</sub> effectively accounts for 77% of total emissions and it is the GHG with the most rapidly increasing emissions. The logical conclusion drawn is that priority action must be taken to reduce CO<sub>2</sub> emissions.

However, it is necessary to analyse this in greater detail if we are to assess the real climate impacts of the different GHGs at different time horizons and particularly in 2030-2050, since this is the time horizon that holds policy-makers' attention.

To understand this, it is enough to examine the two scenarios below, considered as equivalent, based on current rules and which have the common target of a given emissions reduction (in t CO<sub>2</sub> eq) by 2030 e.g. 30%.

The first scenario, S1, is a single GHG scenario: N<sub>2</sub>O, CH<sub>4</sub> and CFC emissions are maintained at their 2004 levels and the required reduction is obtained by focusing merely on CO<sub>2</sub> emissions in order to meet the 2030 target, in accordance with the IPCC rules currently in force.

This requires a 20 Gt reduction in CO<sub>2</sub> emissions (i.e. -40%) over the period 2010-2030. It is proposed to achieve this reduction by means of a linear progression of 1 Gt CO<sub>2</sub>/year over this 20-year period (i.e. each year between 2010 and 2030, an additional reduction of 1 Gt CO<sub>2</sub> is obtained).

The second scenario, S2, involves obtaining all possible reductions of CH<sub>4</sub> emissions that can reasonably be envisaged, and to ensure the possible additional necessary reductions by reducing CO<sub>2</sub> emissions.

Chapter IV (*see below*) shows that the reasonable potential for CH<sub>4</sub> reductions can be estimated at 30% in 2030, and even in 2020, i.e. 110 Mt out of the 360 Mt total of global CH<sub>4</sub> emissions. These reductions are based on a credible programme of measures, focusing on capturing a large proportion of methane emitted by landfill sites and sewage sludge, on partial methane recovery from livestock slurry and manure, and on reducing leaks from energy systems (mines, energy transport networks, oil wells).

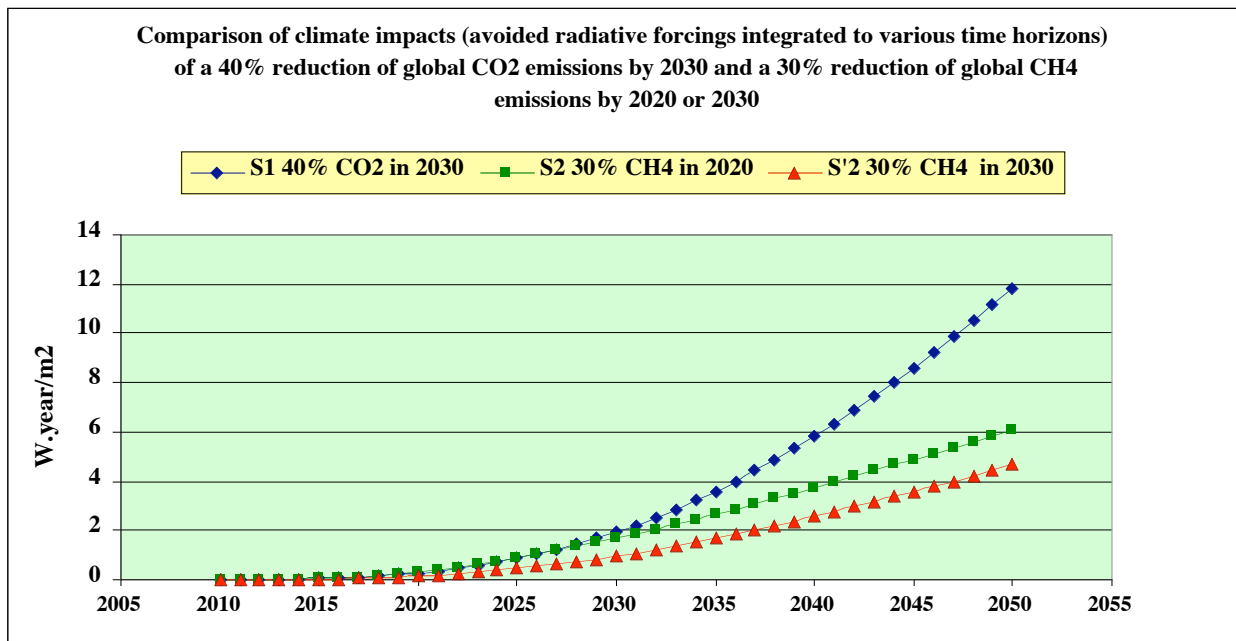
Such a programme can be envisaged within the same timeframe as in the first scenario, with a 5.5 Mt CH<sub>4</sub> reduction per year between 2010 and 2030. This can even be envisaged within a shorter timeframe, between now and 2020, with an 11 Mt/year reduction, as it does not depend on the building or altering of heavy infrastructure.

Using this data, the cumulative effect of the different strategies on climate can be assessed from the time that they are adopted up until a given time horizon (in this case 2050). This can be seen in Figure 3<sup>5</sup>.

<sup>4</sup> These data express the impact of non-CO<sub>2</sub> emissions over the coming 100 years i.e. at the time horizon 2105.

<sup>5</sup> For the methodology used to estimate the cumulative effects on climate, see article "Global warming: the significance of methane" by B. Dessus, B. Laponche, H. Le Treut, on [www.global-chance.org](http://www.global-chance.org).

Figure 3



Several key lessons for taking action can be learned from this figure.

The first lesson is that methane reduction measures, whatever their dynamics may be, are far from being marginal compared to those that can be implemented solely to reduce CO<sub>2</sub> emissions. If the two programmes (CO<sub>2</sub> 40%) and CH<sub>4</sub> (30%) are implemented at the same rate until 2030, the effectiveness of the CH<sub>4</sub> programme reaches 49% of that of the CO<sub>2</sub> programme in 2030. It is still 44% in 2040 and 39% in 2050.

The second lesson concerns the dynamics of the programmes. If, as it is likely, the CH<sub>4</sub> reduction programme can be implemented by 2020, its effectiveness is significantly improved: 88% in 2030, 64% in 2040 and 57% in 2050.

The following table compares more diversified strategies during the period 2020-2050.

Avoided cumulative radiative forcing (W.year/m <sup>2</sup> )	2020	2030	2040	2050
CO <sub>2</sub> : 20% in 2020	0.3	1.8	4.6	8.4
CO <sub>2</sub> : 20% in 2030	0.15	1	2.9	5.9
CO <sub>2</sub> : 30% in 2020	0.45	2.7	6.9	12.5
CO <sub>2</sub> : 30% in 2030	0.21	1.45	4.35	8.8
CO <sub>2</sub> : 40% in 2030	0.3	1.93	5.8	11.85
CH <sub>4</sub> : 20% in 2020	0.15	1.1	2.5	4.1
CH <sub>4</sub> : 20 % in 2030	0.1	0.63	1.75	3.15
CH <sub>4</sub> : 30% in 2020	0.3	1.7	3.95	6.1
CH <sub>4</sub> : 30% in 2030	0.15	0.95	2.6	4.7

These results confirm that the impact of rapid action to reduce methane emissions, even if relatively modest, is always considerable in **short- and medium-term** climate strategies.

Obviously, the effectiveness of this reduction dwindles over time: the effectiveness of the CH<sub>4</sub> 30% reduction programme by 2030, compared to the CO<sub>2</sub> 40% programme at the same time horizon, falls from 39% in 2050 to 25% in 2100 and to 18% in 2150. This latter point justifies the need for proactive CO<sub>2</sub> emission reduction measures, which remain vital to guarantee that the **long term target** is met.

#### IV. – THE POTENTIAL FOR REDUCING METHANE EMISSIONS

##### Breakdown of methane emissions

Anthropogenic methane emissions are not accurately known for two reasons: firstly, it is more difficult to estimate CH<sub>4</sub> emissions than CO<sub>2</sub> emissions since most of the latter come from fossil fuel combustion which is easy to calculate. Secondly, the international community's attention has not focused on CH<sub>4</sub> emissions. However, global indications are available which provide orders of magnitude of the breakdown of these emissions by sector and by major region.

##### Breakdown of methane emissions by sector

CH <sub>4</sub>	Million tonnes (Mtonnes)	Percentage
Agriculture (livestock farming and rice cultivation)	135	38%
Energy systems (leaks, firedamp, etc.)	118	33%
Household waste and wastewater treatment	82	23%
Industry and forest fires	22	6%
<b>Total</b>	<b>357</b>	<b>100%</b>

Source : IPCC Working Group III Summary for Policy Makers, 2007.

##### Indicative breakdown of methane emissions by region

1990	OECD countries	Asia (non OECD countries)	North Africa + Latin America	Countries with economies in transition + Sub-Saharan Africa	Total
Percentage	24%	37%	22%	17%	100%

Agriculture is the main emissions sector, predominantly as a result of livestock, except in Asia where rice cultivation accounts for two-thirds of agricultural emissions. The second largest sector responsible for CH<sub>4</sub> emissions is energy systems, followed by emissions from household waste landfill sites. Lastly, deforestation and the slash and burn technique used in savannahs are a significant cause of CH<sub>4</sub> emissions in African countries and Latin America.

##### Short and medium term reduction potentials by sector

###### *Agriculture (38%)*

Emissions from agriculture have risen slightly since 1990 (<10%). Livestock farming accounts for almost 60% of agricultural emissions, the rest mainly coming from rice cultivation under water. In Western countries where more accurate data series are available, two-thirds of livestock emissions come from enteric fermentation of ruminants and one-third from manure and slurry.

###### *Energy systems (33%)*

Emissions come from coal mines (firedamp), losses from oil and gas fields, leaks from the natural gas transport and distribution networks and, marginally, from the automobile sector. Global emissions from this sector have increased by more than 15% since 1990.

**Landfill sites and wastewater treatment (23%)**

More than 85% of emissions come from household landfill sites, with the remainder coming from wastewater treatment. Emissions from this sector are rapidly increasing as a result of urbanisation and economic development in the emerging economies.

**The greatest reduction potentials are found:**

- In the energy sector where, subject to a more accurate country-by-country analysis, it is estimated that 50% of emissions can be feasibly captured in the short term (in particular, firedamp in coal mines and pre-flare leaks from oil wells).
- In the household waste sector where 50 to 60% of landfill sites could be made leakproof in the short term and where methane could be captured (following the numerous examples of projects in Europe).

The short term reduction potentials in agriculture are more marginal except for methane recovery from slurry and manure which could, in the medium term, account for 20 to 30% of the potential.

The following table summarises the order of magnitude of the potential identified.

**Order of magnitude of the short- and medium-term methane emissions reduction potential by sector (10-20 years)**

	<b>Reduction potential Mt</b>
<b>Energy systems</b>	59
<b>Landfill sites</b>	42-49
<b>Livestock farming</b>	10-15
<b>Total</b>	111 - 123

The total reduction potential is thus around 30% of current emissions (357 Mt).

Beyond this, in the medium term, a number of measures can be envisaged in agriculture: implementing rice cultivation and livestock feed methods low in CH<sub>4</sub>, stepping up the control of fugitive emissions from energy systems and capturing methane from landfill sites.