DEVELOPMENT AND CLIMATE CHANGE:
THE IMPORTANCE OF A METHANE REDUCTION POLICY
FOR THE 21ST 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_2eq[1] 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_2eq during this century (or at close to 3 Watts/m^2 of radiative forcing[2]), falling to 400 ppmv CO_2eq (or 2 W/m^2) beyond 2100, a rise of more than 2°C will be avoided.

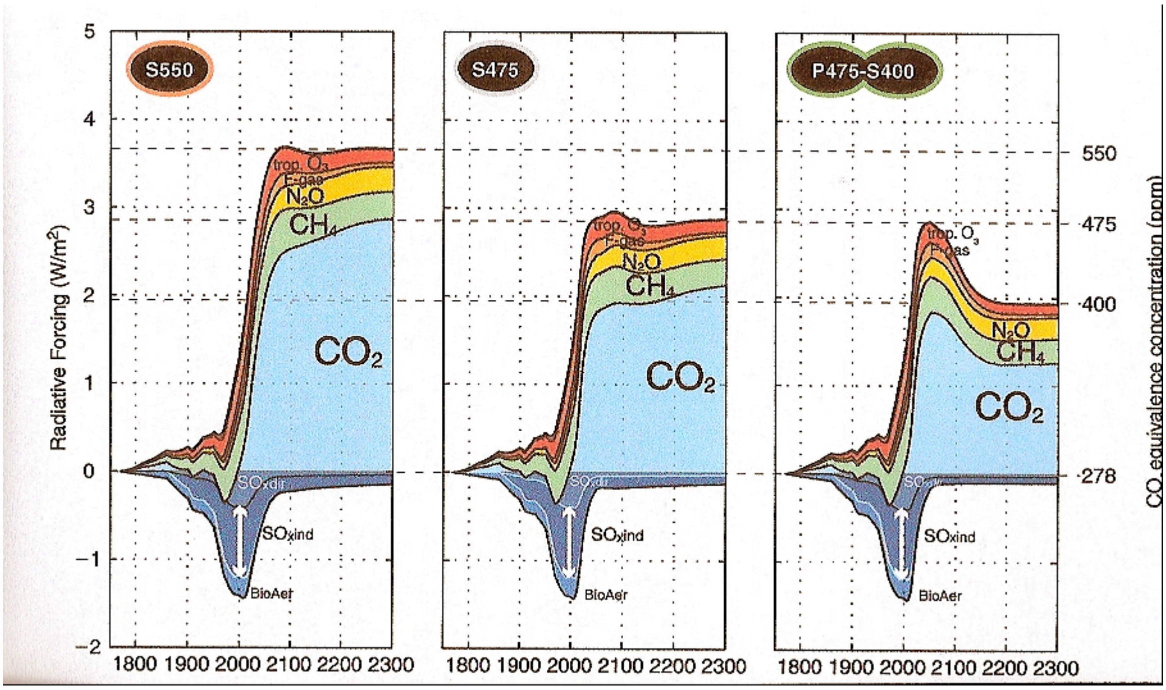


Figure 1 : Contribution of the different radiative forcing components to net radiative forcing for paths leading to stabilisation at 550 to 400 ppmv CO_2eq. The upper boundary of the curves shows anthropogenic radiative forcing. The net cooling effect caused by direct and indirect effects of various aerosols (SOx and biomass) is indicated by the negative boundary of the curves. The arrows indicate the high level of uncertainty concerning forcing due to SOx.
Source : Malte Meinshausen – Swiss Federal Institute of Technology (ETH Zurich).

[1] CO_2 concentrations with the same climate impact as the concentrations of a given set of GHGs in a given year.
[2] Radiative forcing (in W/m^2) expresses the variation in surface irradiance due to the different GHGs.

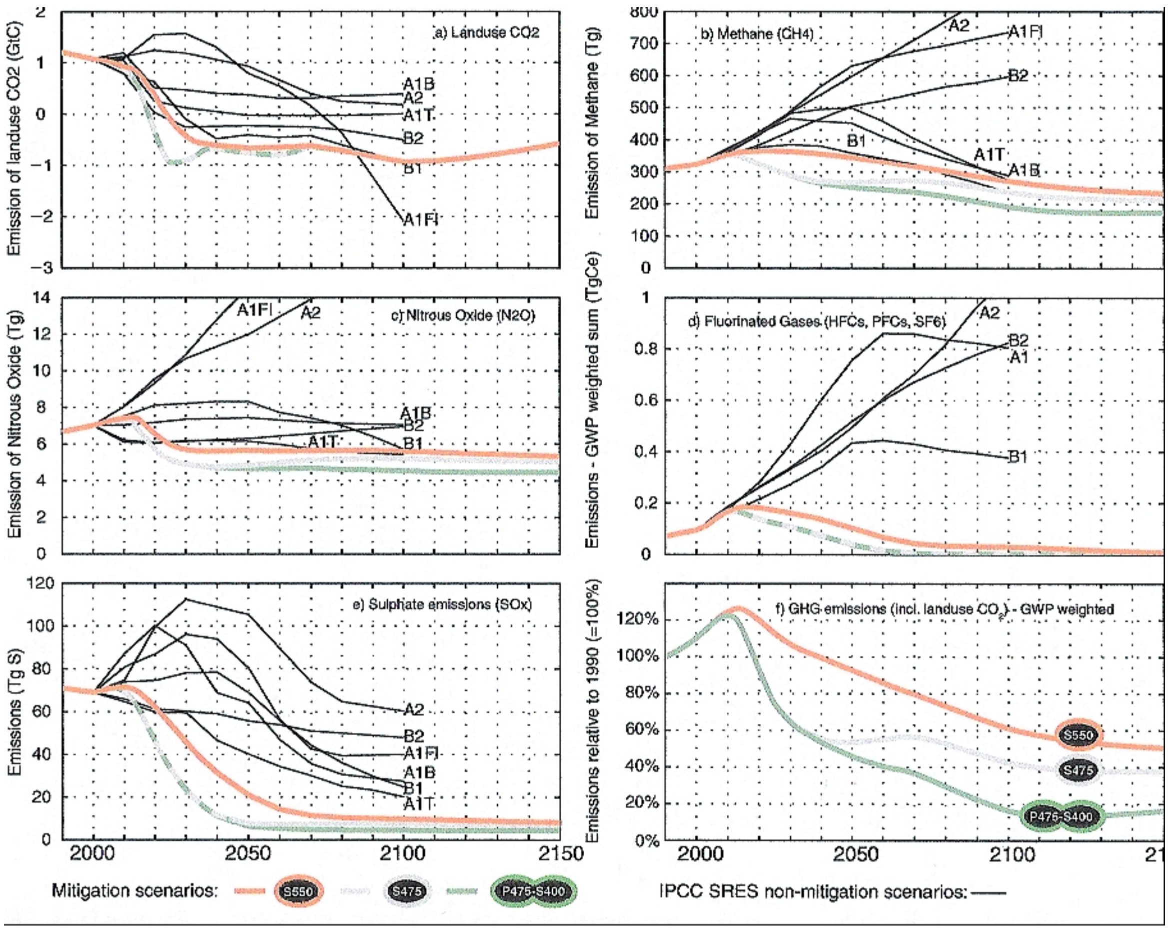
II. WHAT IS THE SITUATION TODAY?

In its latest report, IPCC's Working Group 1 gives quite specific indications of the changes in GHG concentrations (in ppmv CO_2eq) and radiative forcings in recent decades. In 2005, CO_2 concentrations reached 379 ppmv, while additional radiative forcing was 1.66W/m^2 relative to the preindustrial period. The contribution of other GHGs to additional radiative forcing was 1W/m^2 and the negative effect of aerosols was around 0.7W/m^2. This therefore gives a total additional radiative forcing of about 1.6 W/m^2 (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_4 is equivalent to 21 kg CO_2, 1kg N_2O is equivalent to 310 kg CO_2), 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^2) 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_2 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_2 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_2 eq) compared to 1990 levels. Yet, today, GHG emissions are rising at a considerably faster rate than indicated by the 475-400ppm curve[3].

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

[3] GHG emissions increased by almost 24% between 1990 and 2004.

III. A COMPARISON OF CO2-CH4 EMISSION REDUCTION PROGRAMMES

Global GHG emissions in 1990 and in 2004 (expressed in t CO_2 eq, in accordance with the rules currently in force under the Climate Convention[4]), were as follows:

Emissions* in Gt CO_2eq	1990	2004	Difference (2004-1990)
CO_2	29	37.6	+8.6
CH_4	6.8	7.5	+0.7
N_2O	3.4	3.7	+0.3
CFC	0.2	0.4	+0.2
Total	39.4	49.2	+9.8

Looking at these data, it is clear why CO_2 emissions more or less hold policy-makers' full attention. CO_2 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_2 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_2 eq) by 2030 e.g. 30%.

The first scenario, S1, is a single GHG scenario: N_2O, CH_4 and CFC emissions are maintained at their 2004 levels and the required reduction is obtained by focusing merely on CO_2 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_2 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_2/year over this 20-year period (i.e. each year between 2010 and 2030, an additional reduction of 1 Gt CO_2 is obtained).

The second scenario, S2, involves obtaining all possible reductions of CH_4 emissions that can reasonably be envisaged, and to ensure the possible additional necessary reductions by reducing CO_2 emissions.

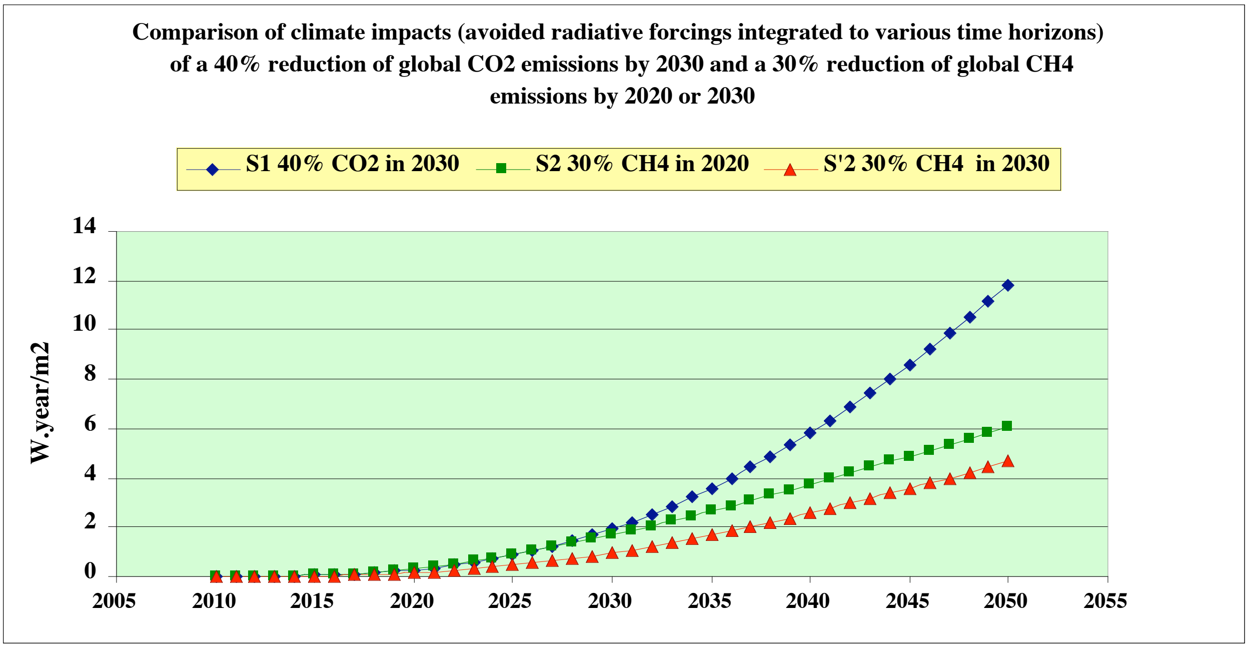
Chapter IV (*see below*) shows that the reasonable potential for CH_4 reductions can be estimated at 30% in 2030, and even in 2020, i.e. 110 Mt out of the 360 Mt total of global CH_4 emissions. These reductions are based on a credible programme of measures, focusing on capturing a large proportion of 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_4 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[5].

[4] These data express the impact of non-CO_2 emissions over the coming 100 years i.e. at the time horizon 2105.
[5] For the methodology used to estimate the cumulative effects on climate, see article "Global warming: the significance of methane" by B. Desssus, B. Laponche, H. Le Treut, on 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_2 emissions. If the two programmes (CO_2 40%) and CH_4 (30%) are implemented at the same rate until 2030, the effectiveness of the CH_4 programme reaches 49% of that of the CO_2 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_4 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 ($W.year/m^2$)	**2020**	**2030**	**2040**	**2050**
CO_2 : 20% in 2020	0.3	1.8	4.6	8.4
CO_2 : 20% in 2030	0.15	1	2.9	5.9
CO_2 : 30% in 2020	0.45	2.7	6.9	12.5
CO_2 : 30% in 2030	0.21	1.45	4.35	8.8
CO_2 : 40% in 2030	0.3	1.93	5.8	11.85
CH_4 : 20% in 2020	0.15	1.1	2.5	4.1
CH_4 : 20 % in 2030	0.1	0.63	1.75	3.15
CH_4 : 30% in 2020	0.3	1.7	3.95	6.1
CH_4 : 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_4 30% reduction programme by 2030, compared to the CO_2 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_2 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_4 emissions than CO_2 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_4 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_4	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%**
Total	**357**	**100%**

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 + Subsaharan 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_4 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_4 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 feasiblily 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)

	Reduction potential Mt
Energy systems	59
Landfill sites	42-49
Livestock farming	10-15
Total	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_4, stepping up the control of fugitive emissions from energy systems and capturing methane from landfill sites.