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A contribution to COP21

The other knob: tackling methane emissions

Synthesis of the international Conference

"Mitigating methane emissions

From science to innovative solutions"

VEOLIA INSTITUTE

AGENCE FRANÇAISE DE DÉVELOPPEMENT

PRINCE ALBERT II OF MONACO FOUNDATION

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Acknowledgements

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The other knob: tackling methane emissions

On November 9th 2015, the Veolia Institute convened a conference in Paris on tackling methane emissions, in partnership with the Agence Française de Développement and the Prince Albert II of Monaco Foundation. This report synthesizes the presentations and discussions as an input to the COP21 process. The following presenters are gratefully acknowledged for their contributions and insights at the conference, which form the main body of this report:

Jean BOGNER, Research professor emerita in the Department of Earth and Environmental Sciences, University of Illinois at Chicago

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Helena MOLIN-VALDES, Head of the Secretariat, UNEP Climate and Clean Air Coalition (CCAC)

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John PARKIN, Deputy Head Plant & Engineering in the Cleansing & Solid Waste Department (DSW) of eThekwini Municipality

Veerabhadran RAMANATHAN, Distinguished Professor of Atmospheric and Climate Sciences at the Scripps Institution of Oceanography, University of California at San Diego

Thomas STOCKER, Professor of Climate and Environmental Physics at the Physics Institute, University of Bern and past co-Chair Working Group I, Intergovernmental Panel on Climate Change (IPCC)

Reiner WASSMANN, Coordinator of the research program on rice and climate change, International Rice Research Institute (IRRI)

Their individual presentations can be retrieved at www.conference-methane.org.

Introduction

Descartes celebrated science as a path for humankind to "become the lords and masters of nature", as remarked by former French Minister Jean-Paul Delevoye in his opening words. But this has succeeded beyond what Descartes might have dared imagine, and to such an extent that science now needs to take on an additional role, as the caretaker of nature. Fortunately science has much to contribute, as our understanding of the functioning of the earth's climate improves rapidly. However this occasionally requires an adjustment of the area of focus, as new scientific insights are established.

One such area that deserves greater attention is the issue of methane emissions. This plays a much greater role in global warming than formerly thought. Fortunately cost-effective solutions are readily available for a significant part of those emissions. Climate scientist Veerabhadran Ramanathan quips that "we have two knobs for bending the curve". One is obviously reducing CO_2, but in this report we focus on the other knob – methane - that now accounts for a third of the radiative forcing that we experience:

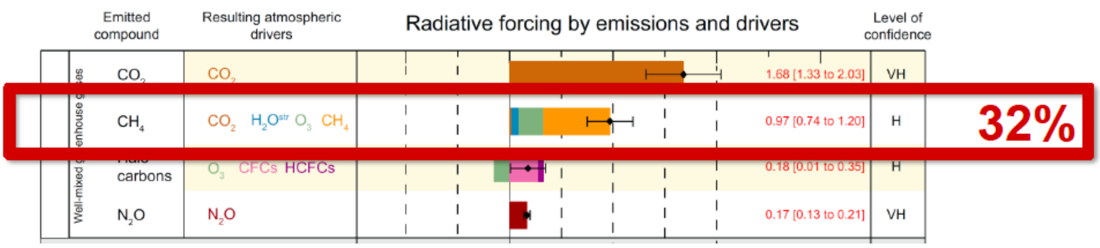

Figure 1 - IPCC 2013 fig. SPM 5 simplified by Thomas Stocker

The reduction of methane emissions is an issue that has received comparatively little attention and its severity is not as well appreciated as for CO_2. The good news is that cost-effective solutions are readily available. Their widespread deployment does require governance and policy support, as well as more assertive action on the part of the private sector.

Bending the curve

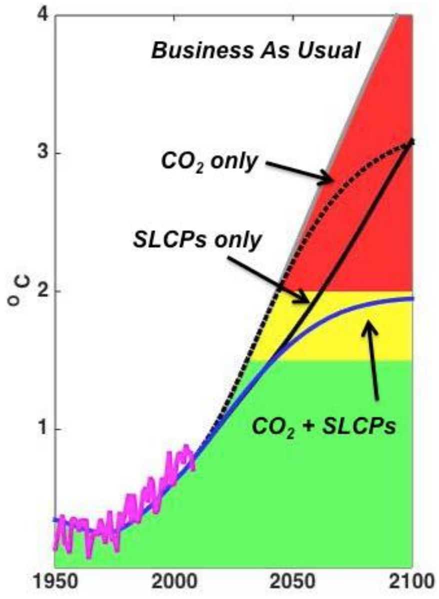

Figure 2 - Ramanthan and Xu, 2010

There are uncertainties around the precise magnitude of the various sources of methane emissions, but one thing we know for certain is that their aggregate result represents the second greenhouse gas in importance, after carbon dioxide (CO_2).

Both gases play a different role, however. Methane stays in the atmosphere for a shorter period than carbon dioxide, but while it is around it has a much greater impact on the climate. While CO_2 lingers for a long time, until it is re-absorbed by nature, half the methane is gone within the first decade. Methane decays into other gases, which then linger.

The consequence is that we should think of these gases in different ways and like apples and oranges, it is difficult to simply add them up. The convention has been to assume that methane is 28 times more potent than carbon dioxide, taking a 100-year horizon. Benjamin Dessus, the co-author of a 2008 AFD study on methane emissions, confirms the understanding that taken over 20 years, methane has an impact 84 times larger. So its impact depends on your time frame and both gases are best considered separately. This requires a change in the conventional accounting for the climate impact of methane.

If humanity had collectively taken action on climate change in a timely and purposeful way, it might have afforded the luxury to focus exclusively on the long term. But as the impact of climate change will be felt much earlier, the luxury no longer exists to think exclusively a century ahead. So in addition to long-term reductions, nearer-term reductions are now essential. That is where measures to reduce methane emissions can play an important role in mitigating the effects of climate change in the short to medium-term. The climate impact of turning the CO_2 knob is greatly delayed, due to the long life of the gas in the atmosphere. In contrast, reducing short-lived climate pollutants (SCLP), of which methane is the dominant one, has a disproportionate effect and is therefore essential.

There are substantial co-benefits associated with reducing methane emissions and other short-lived pollutants. Helena Molin-Valdes of the Climate and Clean Air Coalition (CCAC) estimates that 6 million people die prematurely from SLCP induced air pollution and 110 million tons of crops are lost every year. The richest one billion people are responsible for the majority of this pollution, but it is the poorest three billion who bear the brunt of its consequences, adding an ethical dimension.

The good news is that reducing the emissions of several – not all - sources of methane is in many respects easier than for carbon dioxide. The reason is that there are far fewer co-benefits associated with emitting methane: Whereas carbon dioxide emissions are the result of burning fuels for heating, mobility or industrial activity, methane releases generally provide no useful function. These are often the result of established practices and in some cases the avoided emissions can be cost effectively monetized as valuable fuel. As a result, there is an opportunity to mitigate a substantial part of these emissions.

The chart below lists the main sources of methane emissions from human activity. Note the uncertainty ranges, which indicate that in addition to taking action, improved data is also desirable:

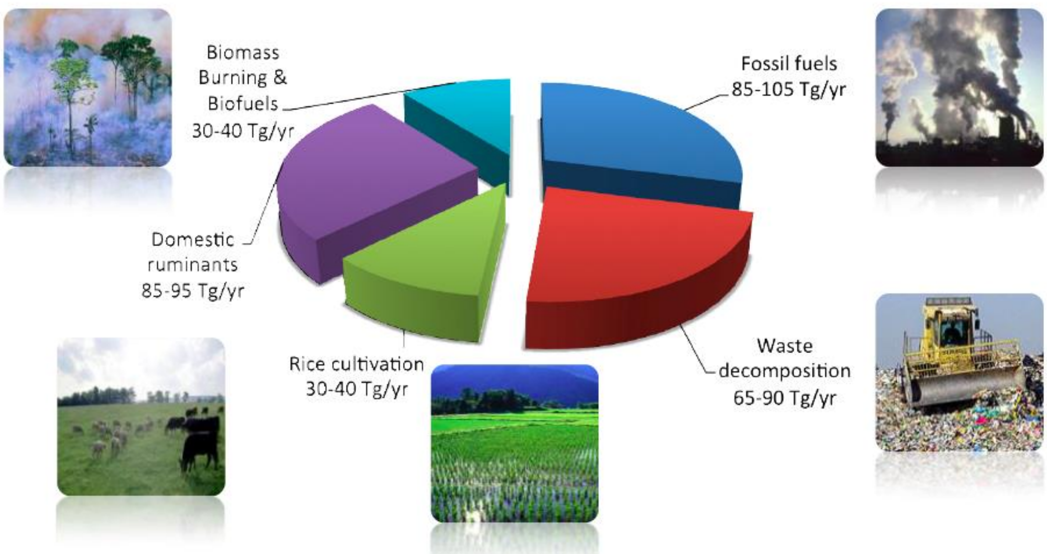

Figure 3 - Anthropogenic methane sources - Global Carbon Project 2013 - quoted by Thomas Stocker

The challenge from agriculture's distributed nature

Half of the methane emanates from agriculture, with livestock being the largest source, followed at some distance by emissions from rice fields. While solutions exist to reduce both, their implementation at scale is challenging. Agriculture is by nature very distributed and deeply intertwined with the world's social systems. For example, 430 million of the world's poor are livestock keepers. Changes are both difficult to make in such vast and distributed systems, but may also have unforeseen consequences, as it inevitably touches brittle social systems.

Nevertheless progress can be made. Changing management and feeding practices is the low hanging fruit that can influence livestock management. The UN's Food and Agriculture Organisation (FAO) estimates that adopting practices that are already prevalent in South East Asia could reduce emissions by a quarter to a third. The biggest culprit is the enteric fermentation in cattle. In essence, microbes break down the cellulose in the feed during rumination, and the animals belch out the resulting methane. This can be tweaked through supplementary feeding, which changes the rumen microbiology, but also through better herd management. Results can be attained without any systemic change, but if changes in behaviour on the part of the livestock holders are matched with changes in behaviour on the part of consumer through reduced meat consumption, even greater strides could be made. However both sides of the system – production and consumption are highly distributed and set in their ways, so they require governance innovation, as well as technical solutions to change them. The FAO's Carolyn Opio characterises the challenges as follows: "To sufficiently deploy large methane abatement measures, it will be necessary to address a number of barriers including limited awareness of emissions levels and reduction opportunities, lack of information on technologies and practices, lack of institutional capacity and methane markets."

Growing rice culture is the second source of methane emissions within agriculture. Rice culture is unique, as it is the only crop grown in submerged fields, and therein lies the problem. This practice leads to methane emissions because the water on top of the soil keeps the air away, and as a consequence the anaerobic decomposition of organic matter in the soil releases methane. The solution is occasionally draining the field, so that the oxygen from the air can reach the soil. The technique is called Alternate Wetting and Drying (AWD) and has been practiced for a long time in areas in China, primarily to save irrigation water. Fortunately 70% of the rice fields in the world are irrigated, instead of rain-fed, which makes application of this technique feasible on a large scale. The International Rice Research Institute's Reiner Wassmann points to the relevance of rice-related emissions: "Globally, rice production accounts for 1.5% of all GHG emissions, but this percentage can reach up to >20% within the national GHG inventories of South East Asian countries."

A project to evolve practices in the nine million hectares of rice fields in the lower Mekong delta demonstrates both the opportunities and the challenges. This demonstrates how scientific findings and publications will not be sufficient by themselves to stimulate mitigation measures, but need to be translated into clear spatial and temporal priorities at multiple scales. The theory of change is to start at village level as catalysts for sub-regions, to spread throughout the entire system to other scales.

Fresh facts on emissions from oil and gas

The estimated quantity of lost methane across the world associated with oil and gas production would rank as the world's seventh largest natural gas producer, matching Norway's total 2012 production. The International Energy Agency (IEA) confirms that "the oil and gas sector is the largest industrial source of global methane emissions, not just from specific types of gas or oil wells, or from a particular region, but rather throughout the globe and from all parts of the industry." At the same time there is a lot of uncertainty around the numbers – but all indications are that the quantity is likely to be even higher. To get better data, catalysed by the Environmental Defense Fund (EDF) a series of studies were conducted in the US with a unique coalition of industry, academic and civil society partners, in order to actually measure emissions along the entire gas value chain.

The results are being published in a series of around 30 peer-reviewed papers. One notable finding from the studies is that methane emissions follow a heavy tail distribution. Readers of Thaleb's Black Swans will recognize that this implies a small number of very large emission sources. This is a very different distribution than would be expected under a normal statistical distribution. Since industry by default assumes normal distributions when extrapolating from sample measurements, their results generally underestimate the total. There is upside to this discovery, as the absolute number of leaks to be fixed is much smaller than anticipated – although of course they still need to be pinpointed.

Separate analyses in Canada, Mexico, and the United States all show that reducing oil and gas methane is incredibly cost-effective in those countries, and that at least a 40% reduction of oil and gas methane could be achieved at a fraction of the value of the gas produced (less than one cent per Mcf). Fixing those leaks does not need any R&D, and merely requires the application of well-known technologies. In many cases the gas that is recovered can be included in the volume for sale, thereby recouping the cost of the investment. CCAC has catalogued the nine main sources of emissions, along with well-established and cost effective fixes.

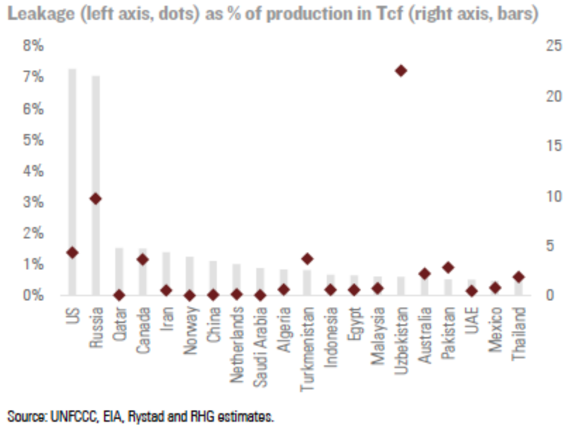

Figure 4 - Natural Gas Leakage Rate (Rhodium 2015)

Comparing the estimated and measured emission rates in the US with that of other countries is instructive. A recent Rhodium report shows that other countries either have natural gas operations that are vastly superior to those in the US in managing their methane emissions, or are greatly underestimating what is being released into the atmosphere. In both cases, a closer look is warranted, as there are lessons to be learned, one way or the other.

The oil and gas sector is one of the world's best-capitalized industries and one with substantial execution capacity. Since it appears to be responsible for the largest non-distributed anthropocentric emission source of methane, this presents a huge opportunity and responsibility. The Environmental Defense Fund's Drew Nelson states: "If we cut such pollution in half globally, the effect over the next 20 years would be equivalent to eliminating all carbon dioxide from burning coal in India and in the European Union." Doing so will have an immediate climate benefit, but requires companies and governments to announce policies and implement actions to reduce methane emissions from oil and gas.

Wasted methane

Figure 5 - Landfill methane removal in Latin America - quoted by Josep Fernandez

As is apparent in Figure 3 above, waste decomposition and wastewater is one of the big three sources of anthropogenic methane.

When municipal solid waste is first deposited in a landfill, it undergoes an aerobic (i.e. with oxygen) decomposition stage when little methane is generated. Then, typically within less than one year, anaerobic conditions are established and methane-producing bacteria begin to decompose the waste and generate methane. The methane most often is simply released into the air, but in principle can be captured. The resulting gas requires treatment to remove impurities, and can then be either flared or burned for power. Variability between sites is substantial and much progress is still ahead on better modelling to quantify the volumes. As Jean Bogner of the University of Illinois highlighted, there is often a lag between the availability of more advanced models and their applications to support policy. She describes how over the last decade, an improved science-based modeling strategy for site-specific landfill CH_4 emissions has been developed and independently field-validated for California and field-validated on 6 continents.

But while the technology to capture the methane is relatively straightforward, in practice there are many hurdles to doing this at scale. Veolia's Josep Fernandez has experienced many projects in central and South America, and describes the difficulties of doing this. In Latin America there is often a lack of common rules: Landfill tariffs vary from €4 to €25 per ton; power prices range from €3 to 100 per MWh; the ownership of the biogas is not clear, sometimes it is the municipality's, sometimes the private operator, sometimes it is negotiable. A low power price has caused the gas to be flared in a project in Caracas, instead of converting it into power as originally envisaged. Doing these projects at scale requires good regulation, along with a reasonable capacity for enforcement. Mechanisms such as the Clean Development Mechanism (CDM) are in practice very burdensome to use, as evidenced by the experience of a large project in Durban. Still, overcoming substantial hurdles, John Parkin of eThekwini Municipality helped lead this project to become a success story and the largest waste-to-power plant in Africa.

Since the 1970's through a mix of regulation and tax incentives, over 600 projects in the US now yield enough power for 1,5 million US homes. But as is apparent from experiences elsewhere, the challenges to scaling this up globally are largely in the realms of governance and operations.

Arctic relief, tropical worries

There may be more than twice as much carbon contained in the northern permafrost as contained in the atmosphere itself. It has been built up over thousand and thousands of years and it is starting to thaw. While the quantity of methane is enormous, there is also some comforting news from the historical record.

Figure 6 - Nature cover May, 15, 2008

Air bubbles trapped inside Antarctic and Greenland's ice masses provide a useful window on the composition of the atmosphere over 800,000 years. This allows a precise mapping of the carbon dioxide and methane concentrations. It is well known that carbon dioxide concentrations have varied greatly over the millennia, as is visible in the ice ages with both low CO_2 and methane. The crucial question today is whether the current rapid increase in CO_2 concentration is likely to trigger disproportionate releases of methane from the permafrost?

Looking back in history – there are some puzzling peaks in methane. Where did they come from? Comparing Antarctic and Greenland ice cores, we can locate where the emissions occurred. It turns out that the tropical sources were dominant, with a smaller contribution from the arctic. You can also do isotopic fingerprinting, which also determines the source. The IPCC's Thomas Stocker confirms that "the analysis of the interhemispheric gradients points to tropical methane sources." So the verdict is that the historical record traces the release of methane during previous warming periods mainly back to tropical wetlands, rather that to arctic thaw. Although humanity is stressing the earth's system beyond any historical precedent on its current path, currently at 120% of highest point in the past 800,000 years, there is no indication from the past that arctic carbon release will be catastrophic.

Emissions from wetlands on the contrary are rising, as indeed they have done historically with increasing concentrations of greenhouse gases. The IPCC in its delicately honed language concludes that "….there is medium confidence that emissions of CH_4 from wetlands are likely to increase in the future." However models remain incomplete and observations are limited in space and time. Large uncertainties persist as our understanding of the climate dynamics grows.

Economic considerations

"The world grants $650 billion in subsidies and tax exemptions to oil, gas and coal, amounting to average aid of $35 per metric ton of CO_2 for fossil fuels. Rather than a penalty of €30 per metric ton of carbon emissions, we in fact have a €30 subsidy" stated Veolia's Chairman and CEO Antoine Frérot. AFD's Chief Economist Gaël Giraud pointed to further deficiencies in the economic governance system, as even the macro-economic models that help steer decision-making do not incorporate climate considerations. The result of these misaligned incentives is very slow progress, with continued global coupling of economic growth and greenhouse gas (GHG) emissions. It is worth highlighting California, amongst a small number of notable exceptions, which realised a 20% drop in GHG per unit of GDP from 2000 to 2013. This demonstrates that in principle at least, economic growth and decreased carbon intensity are possible.

In a world awash with low-cost capital following the central banks' decisions to open the cash spigots after the 2008 financial crisis and presented with a plethora of cost efficient measures to reduce methane emissions, it is clear that mechanisms to overcome market failures are required. As highlighted above, in particular for methane recovery in landfills and agriculture the low carbon price, as well as its high volatility present high hurdles. The World Banks' Tanguy De Bienassis presented an example of a new instrument for improving this situation, the Pilot Auction Facility (PAF). This offers a guaranteed price floor for methane projects through put options, underpinned by an auctioning system. At scale, this could provide further assistance for private sector investment in methane reduction projects.

The call for a robust carbon price is not new and will be heard from many quarters at COP21. However given the increased recognition that methane emissions contribute a third of the warming effect, this raises the question whether a distinct methane price should be considered. The current practice of simply converting methane to CO_2 equivalence with a factor 28 was condemned by all speakers as not doing justice to the actual role of the methane. Coupled with the large number of cost-efficient and profitable mitigation projects that are available, valuing methane emissions explicitly may well represent the proverbial low hanging fruit.

Turning the knob

Antoine Frérot, noted that "the sad mathematics of CO_2 should not make us sigh and give up. The defeat of humankind by the climate is not unavoidable. Pragmatism and ambition are the two principles that must guide us in inventing a low-carbon future and protecting the atmosphere, in a reflection of all our contradictions and mutual dependence."

The Veolia Institute Conference deliberations suggest five priority areas to mitigate methane emissions:

1 Putting a price on methane would be effective.

It is clear that reducing methane in the short-term is essential and its influence is big enough to challenge the practice of bundling it with CO_2. A powerful driver for action would come from pricing it at 84 times carbon dioxide. As Gaël Giraud of Agence Française de Développement says "a single carbon market is an illusion, and is actually not useful. In reality you need different prices to incentivize a German engineer and a Malian farmer". Similarly you can consider a different price for methane and for carbon dioxide emissions.

2 Most rapid progress can be made in the oil and gas sector.

Of the three big sources of methane emissions, most rapid progress can be made in the oil and gas sector. It is the most concentrated, both physically and in terms of the companies operating in the sector. Capturing methane also happens to be one of its core businesses. Most measures will have positive returns, although perhaps not all meeting the very high hurdle rates of the industry. Pricing methane can help in this respect, as would more companies joining initiatives such as CCAC's Oil and Gas Methane Partnership, as well as following IEA recommendations to set methane reduction goals and implement regulations to meet those goals.

3 Reducing methane from landfills is doable and can be profitable.

The recovery of methane from landfills is technically doable and can be profitable. It requires putting a proper price on the methane emissions that are applicable at the landfill site. Assuming a waste collection chain in place, it also requires the ability to monetize the recovered methane by having clear ownership and a reasonable local power market. The solutions lie on the shelf and can readily be deployed at scale. In order to make the business model work, enabling policies and support mechanisms (such as feed-in tariffs) need to be put in place.

4 Agriculture has immense potential for reducing methane.

Agriculture has immense potential for reducing its methane emissions, but the distributed nature of the sources and the deeply embedded practices in supply and consumption imply that progress will be more gradual and multiple strategies will be required. Fortunately these exist, whether through CCAC or sector-focused organisation such FAO or IRRI. New financial instruments such as the World Bank's PAF can further support progress.

5 Better data is needed.

Better data is needed, but it will likely require new forms of partnerships to gather it. In many sectors the individual emission factors are reasonably well understood, whether it concerns a gas well or a rice field. The uncertainty is often in the number of sources and in the patterns of behaviour that drive emissions in practice. Such studies will not only produce better data, but also insights into how practices can be changed.

As the conference presenters noted, reducing methane emissions seems tantalisingly doable, cost effective and not resisted by vested interests. So it is time to accelerate turning the second knob. Taking the long view, the former President of the Québec region Pierre Marc Johnson concluded with the thought that while success in reducing methane emissions is important for its own sake, it could also give hope that solutions are accessible for climate change as a whole.

List of figures

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Figure 3 - Anthropogenic methane sources - Global Carbon Project 2013 - quoted by T. Stocker in Veolia Institute conference, Paris, November 2015.
Figure 4 - Natural Gas Leakage Rate (Rhodium (2015) *Untapped Potential: Reducing Global Methane Emissions from Oil and Natural Gas Systems*, Rhodium report, April)
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A conference extended by two side events at COP21

More information on the event?

www.conference-methane.org
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