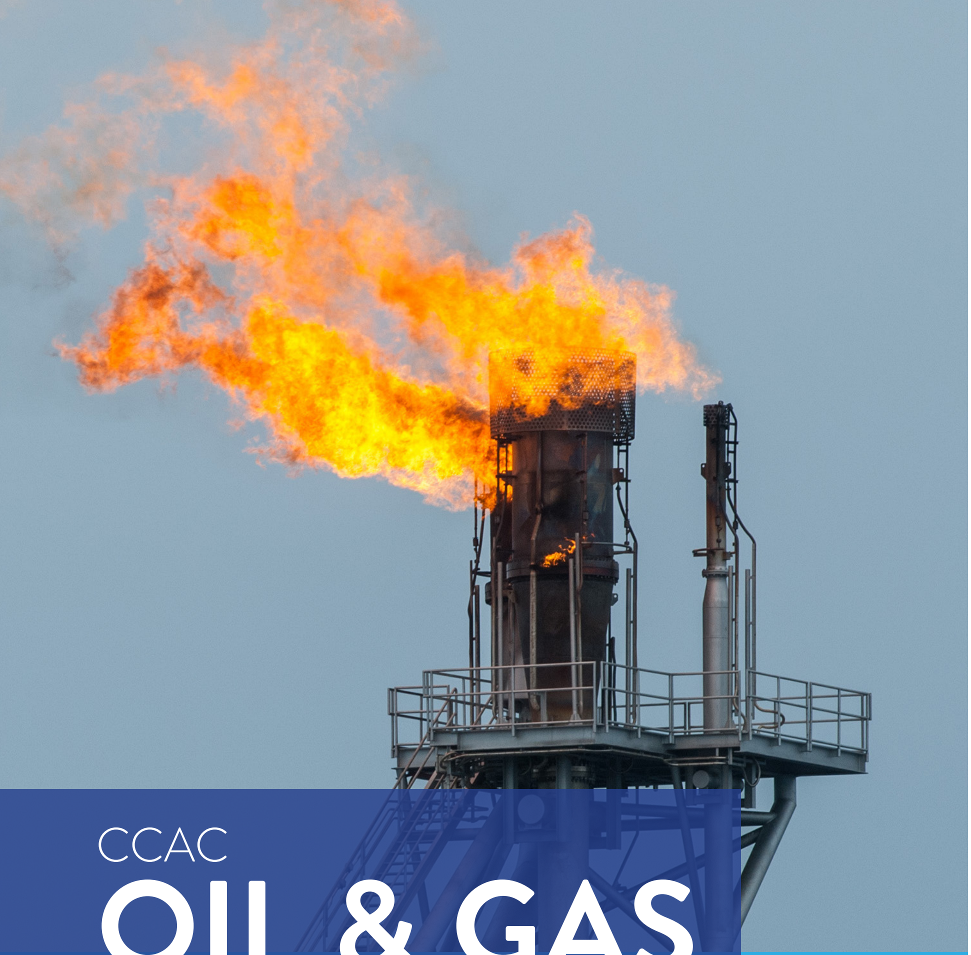


CCAC
OIL & GAS
Technology Demonstration project

ASSESSING BLACK CARBON FROM FLARING USING LEAP-IBC

Introduction

The World Bank launched a new global initiative in 2015 to reduce routine gas flaring at oil fields to address growing concerns over its serious threat to human health and its environmental impacts. 300 million tonnes of carbon dioxide are produced every year as a consequence of flaring. Short Lived Climate Pollutants (SLCPs) such as methane and black carbon are also produced during flaring. These are harmful air pollutants that also contribute to climate change. Methane is over 20 times more potent than carbon dioxide, and has an atmospheric lifetime of about 12 years. Flaring represents a huge loss economically in terms of potential revenue from the sale of by-products made from the gas (which is primarily methane). Also, there is potential for significant local socio-economic benefits by helping to build more resilient communities. For example, gas that would have been flared could be used for electricity generation to support local populations.

LEAP, The Long-range Energy Alternative Planning software

The Long-range Energy Alternative Planning software, LEAP, allows users to calculate emissions of a wide range of pollutants for different sectors, including SLCPs, from different emissions sources within a country. Emissions can be calculated for a base year, based on how emissions will develop based on current trends, and for different scenarios to assess the effect of different policies or mitigation strategies aimed at reducing emissions and impacts of pollutants. For instance the impact of reducing routine flaring by 2030 can be modelled using the software.

CLIMATE & CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

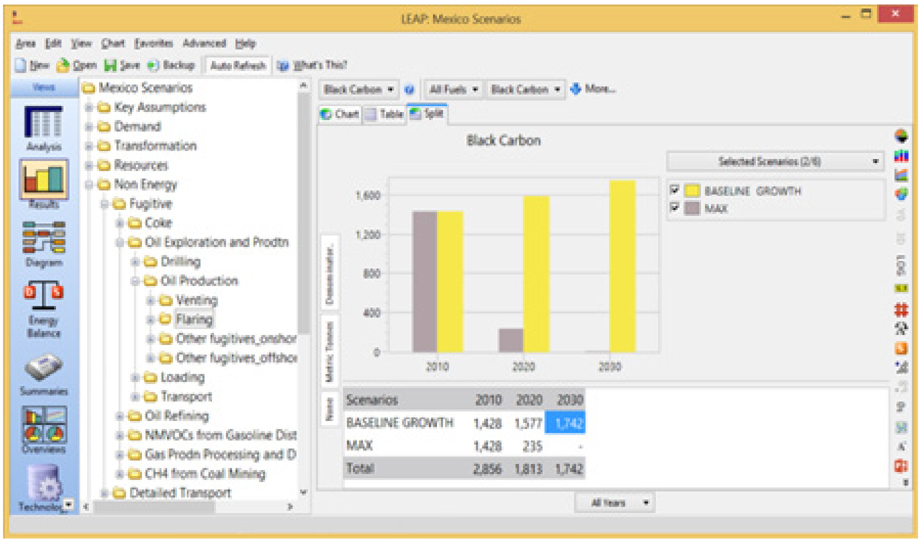
INTEGRATED BENEFITS CALCULATOR (IBC)

For the CCAC Supporting National Action and Planning (SNAP) Initiative, LEAP has been merged with a new tool, called the ‘Integrated Benefits Calculator’, or IBC. LEAP-IBC can calculate emissions of pollutants from different source sectors for different scenarios, and with the addition of the benefits calculator allows these emissions to be converted into concentrations of black carbon (BC), particulate matter ($PM_{2.5}$) and ozone (O_3). These are then used to calculate the climate impacts in terms of temperature change; the health impacts in terms of premature deaths using relationships between concentrations and mortality; and crop impacts in terms of yield loss resulting from these air pollutants.

DATA REQUIREMENTS

LEAP is a relatively simple model which requires activity data from different sources to be compiled e.g calculating emissions from ‘Oil Refining’, requires the yearly total of tonnes of oil refined per year. Default emission factors are used to calculate total emissions of each pollutant. National scale analysis default data are obtained through readily available datasets such as the International Energy Agency (IEA). The data requirements for the oil and gas components in LEAP (Non-Energy Fugitive Emissions) are:

- Oil wells drilled per year
- Offshore/onshore oil production
- Flaring
- Tankers (Exports)
- Pipeline capacity
- Gas processing, production and distribution



LEAP contains a default database of emission factors which are taken from the literature. For oil and gas production, methane emissions factors from venting are from the Intergovernmental Panel on Climate Change (IPCC) and for black carbon the emission factor is from McEwen and Johnstone (2012). There is still some uncertainty in these emissions factors but they can be overwritten if new ones are produced.

SCENARIOS DEVELOPMENT

Data is entered for a 'baseline' year, 2010, and a scenario developed where expected changes in the oil and gas variables over the next 20 years are specified. This can be based on previous trends or forecasts published by the industry e.g oil exploration increases production.

Further scenarios can then be developed, to assess measures such as reducing flaring to zero. The effects of such interventions on emissions, health impacts and climate change can then be compared to the baseline scenario.

CASE STUDY - MEXICO

Mexico is one of the largest oil producers in the World, ranking 9th in the world in crude oil reserves

Map shows the location of flare sites near to urban areas in Mexico.

although production is decreasing in part due to decreases in output in the Cantarell oil field. Petróleos Mexicanos (PEMEX) is the state-owned company that carries out exploration for and extraction of petroleum as well its processing and distribution. Recently, the petroleum industry in Mexico was opened up to private companies. In terms of flaring Mexico is ranked 15th in the world (GGFR, 2012). According to PEMEX and the Ministry of Energy it peaked in 2008 with approximately 3.5 billion cubic meters (bcm) whereas current levels are approximately 2.8 bcm. The peak coincided with the need to flare gas at the Cantarell oil field, because the high nitrogen concentration in the oil could not be utilized. The Government sets annual limits for flaring and venting and imposes fines for breaching them.

DATA INPUT

Data from PEMEX annual statistics. are used in the tool. The World Bank dataset on national flaring volumes was used instead.

SCENARIOS

Two scenarios were modelled: Baseline Growth (BG) and Maximum Reduction (MR). The BG scenario considers there still to be potential for further oil exploration and is based on current industry expectations however this can be highly variable depending on a number of factors such as market conditions, locations of productive oil and gas fields as well as regulatory impacts.
Under the MR scenario, a reduction in venting is foreseen due to improved operations and by re-using the gas (methane) either as a liquid or to generate electricity. In BG, growth was constrained due to uncertainty in the market due to low prices. Under MR, flaring is reduced according to the zero routine-flaring initiative where flaring is eliminated by 2030. In reality, there will still some amount of non-routine flaring for operational and safety reasons.

RESULTS

Overall, black carbon (BC) emissions are small compared to other sectors. Annual emissions are shown in the table below. Under the MR scenario, in 2030 BC emissions from flaring are zero. However, by comparing the two scenarios the cumulative total reduction over 20 years (2010-2030)

Black Carbon Emissions (tonnes)			
Scenarios	2010	2020	2030
BG	1,428	1,577	1,742
MR	1,428	235	

is approximately 3 tonnes.

LEAP-IBC does not attribute any deaths due to black carbon from oil and gas flaring. In comparison, methane reductions are significant approximately 150 kilotonnes (kt). The scenarios assume the methane capture technology has been developed and used to convert the methane in other products such as Liquid Natural Gas (LNG), used as a catalyst in bio-refineries or made into fertilizer.

Methane Emissions (ktonnes)				
Scenarios		2010	2020	2030
BG	Flaring	8.9	13.8	19.3
	Venting	257.6	399.9	557
	Total	266.5	413.7	576.3
MR	Flaring	8.9	12.1	14.4
	Venting	257.6	350.3	416.3
	Total	266.5	362.5	430.7

As this methane utilization has economic value associated further economic analysis could be undertaken. The scenario does not assume that all the methane is captured as some will be still vented due to logistical and infrastructural constraints and also through leakage. Also, some gas can be used in the oil extraction process by re-injecting it into the well to increase the pressure forcing out the oil. There are other serious impacts associated with methane emission in particular the climate change impacts due to the high Global Warming Potential (GWP) of methane. As already noted methane is over twenty times more potent than carbon dioxide, and has an atmospheric lifetime of about 12 years.

CASE STUDY – COLOMBIA

Oil production has increased significantly in Colombia around 2010 after a period of decline. The current target is to produce 1 million barrels per day up from 686,000 bls/d in 2009. Similar to PEMEX in Mexico, Ecopetrol was originally a fully state-owned company but is now part-privatised to make it attractive to investors (in upstream production). Recently, new pipelines and refining capacity has helped increase expand oil production especially off-shore. However, security is a major problem for the industry where attacks on pipelines have led to production stopping as recently as March 2016. Gas production is also on the increase and is being used more for energy production rather than used for re-injecting. Compared to Mexico, Colombia flaring is relatively small-scale.

DATA INPUT

Oil and gas production data were available from Ecopetrol website and BP World Energy Statistics BP 2015). Flaring was taken from the World Bank database. Data for other sectors was sourced from IEA.

SCENARIOS

Similar to the Mexico case study, two scenarios were investigated comparing the BG and MR. The baseline scenarios followed similar a growth pattern however additional gas production is envisaged. Also, there are expected increases in off-shore production as new fields are opened up for foreign companies to explore. Whilst there is no guarantee that oil will be found nor the quantity of oil that will be produced it is highly feasible that overall production in Colombia will increase.

RESULTS

Black carbon from flaring is less than 0.6 tonnes in 2030 under the BG scenario with an overall reduction of 1.5 tonnes over the time period. The comparison between methane emissions is more pronounced with up to 180 kt difference by 2030. Black carbon emissions are small in Colombia based on the flaring data available. Much of the gas associated with production which is utilized for other processes e.g. re-injection rather than currently being flared or it could also be vented and hence not captured in the data. There could be potential to reduce methane emission significantly depending on the scale of technology that is introduced.

OVERALL ASSESSMENT

This activity has used the LEAP-IBC tool to model the reduction in black carbon emissions from flaring in Mexico and Colombia. A policy to reduce flaring is necessary to reduce BC emissions. However, the biggest impact is felt by implementing technology which utilizes the wasted gas (i.e before it is flared). The gas has an economic value plus it can be a resource to local communities for heating, power and food production. Whilst BC emissions from flaring alone in each country are relatively small when added together with other sources – transport, brick production, waste burning and cooking stoves then the overall contribution by each country to SLCPs is important. Other CCAC initiatives have demonstrated how BC can be reduced and the associated benefits it can yield.

References

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World Bank statistical dataset http://data.worldbank.org/country/colombia

World Bank statistical dataset http://data.worldbank.org/country/mexico

MORE **INFORMATION**

www.ccacoalition.org/en/initiatives/oil-gas

www.ccacoalition.org

ABOUT THE **CCAC**

The Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC) is a voluntary global partnership of governments, intergovernmental organizations, business, scientific institutions and civil society committed to catalysing concrete, substantial action to reduce SLCPs (including methane, black carbon and many hydrofluorocarbons). The Coalition works through collaborative initiatives to raise awareness, mobilise resources, and lead transformative actions in key emitting sectors.

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