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Smoke and mirrors

Why the climate promises of the Southern Gas Corridor don't add up

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Authors:

Nualart-Corpas, J. (*,1)
Rosas-Casals, M. (2)
Perez-Lopez, A. (1)

(*) Correspondance: josep.nualart@odg.cat

(1) Observatori del Deute en la Globalització (ODG), c/ Girona 25. 08028, Barcelona.

(2) University Research Institute for Sustainability Science and Technology, Polytechnic University of Catalonia, c/ Jordi Girona 31, 08034, Barcelona.

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EXECUTIVE SUMMARY

The Southern Gas Corridor (SGC) is an inter-connected system of gas pipelines stretching nearly 3,500 kilometers in length that will bring between 10 and 31 billion cubic meters (bcm) of fossil gas from Azerbaijan to Italy. It is portrayed as both reducing Europe's dependency on Russian gas and as a solution for the lack of resilience of the gas system in southeastern Europe. However, it has a high cost, around USD 45 billion, and has the support of public finance institutions, such as the European Investment Bank and the European Bank of Reconstruction and Development. But to date, no climate impact assessment of the full Southern Gas Corridor has been made public by any EU institution involved in its promotion and financing, including the European Commission and European Investment Bank[1].

In this context, the aim of this study is to quantify the fugitive emissions produced along the fossil gas supply chain of the Southern Gas Corridor, focusing on extraction and transmission operations. Moreover, it has also taken account of carbon dioxide (CO_2) emissions generated from combustion, assuming that SGC's fossil gas is used as input energy in Combined Cycle Gas Turbine power plants.

The results obtained in this study show that fugitive emission values in over half of the scenarios are either around the 3 percent threshold defined by the International Energy Agency (IEA) – beyond which fossil gas stops delivering a climate benefit as compared to coal – or well above this threshold [2]. The analysis shows a high risk that the gas from the Southern Gas Corridor would be as climate-damaging as coal. It also shows that the Southern Gas Corridor already in its first stage will cause annual carbon dioxide emissions of at least 55 000 ktCO_2eq which is comparable to the annual emissions of Bulgaria.

Institutions such as the European Commission and the European Network of Transmission System Operators of Gas (ENTSO-G) are promoting fossil gas as a transition fuel because it is the fossil fuel with the lowest emissions intensity. However, it is mainly composed of methane (CH_4), whose so called "Global Warming Potential" (GWP) (which shows how much heat a gas traps in the atmosphere) is 86 times higher over a 20 year time span compared to carbon dioxide. This value can even increase up to 105 if methane's indirect radiative effects are taken into consideration. The methane GWP value currently considered by the European Investment Bank is 25, for a 100 year time span. Applying this methane GWP value for

1 The EBRD has on Bankwatch's request disclosed climate impacts assessment for Southern Gas Corridor commissioned with Carbon Limits

2 International Energy Agency, World Energy Outlook 2017

climate impacts analysis is incorrect, as it is derived from outdated Intergovernmental Panel on Climate Change reports and does not correspond with methane's atmospheric residence time of 12 years.

It is assumed that the SGC's natural gas is used as input energy in Combined Cycle Gas Turbine power plants. The results obtained in this study show that fugitive emission values for almost half of the scenarios generated are close to the 3 percent thresholds defined by the International Energy Agency (IEA) in the World Energy Outlook 2017, beyond which natural gas stops delivering a climate benefit as compared to coal.

There is a lack of scientific consensus regarding fugitive emissions for all fossil gas supply chain operations, primarily for extraction operations. In the case of studies and reports that determine the emissions factor in transmission operations, the scaling-up of fugitive emissions corresponding to the transmission components are much lower than those estimated by a generic approach. Moreover, the number of studies which evaluate the fugitive emissions associated with European gas import pipelines is limited.

As a conclusion, "coal thresholds" must be considered as an inadmissible limit for fugitive emissions produced along the gas supply chain. From a climate perspective, the huge amount of public financial resources and political support for a limited climate benefit cannot be justified. Therefore, the precautionary principle should be applied to the SGC project because of the evident risk that it will significantly contribute to increasing greenhouse gas emissions. Given that gas is mainly used for generating electricity, low carbon alternatives (i.e., energy efficiency and renewable energy) must be considered instead.

INTRODUCTION

The Southern Gas Corridor (SGC) is an inter-connected system of fossil gas pipelines stretching nearly 3,500 kilometers in length that will bring between 16 and 31 billion cubic meters (bcm) of fossil gas from Azerbaijan to Italy[3]. The SGC comprises three different pipelines: (1) South Caucasus Pipeline Expansion (SCPX), Azerbaijan- Georgia; (2) Trans-Anatolian Pipeline (TANAP), Turkey; and (3) Trans-Adriatic Pipeline (TAP), Greece-Albania-Italy. The promoters of the project portray it as the solution for reducing Europe's dependency on Russian gas as well as for addressing the lack of resilience of the gas system in southeastern Europe. However, it has a high price tag of approximately USD 45 billion, and it has been shown that many of the contractors winning contracts for the project have been implicated in corrupt activities[4]. It is financially supported by a number of multilateral development banks, such as the World Bank, Asian Infrastructure Investment Bank, European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD)[5].Fossil gas is the only gaseous fossil fuel and can be extracted from specific natural well-pads or as a sub-product from oil well-pads. Its main component is methane (CH_4), between 87percent and 97percent[6], and its atmospheric residence time is 12 years. For this reason, it is important to evaluate the fugitive emissions produced along fossil gas transmission infrastructure, such as the SGC, given methane's Global Warming Potential (GWP), which reaches 86 in a 20 year time span in comparison to carbon dioxide. The GWP value of methane considered by decision makers is 25, which is incorrect to apply for a climate impact analysis since it is derived from previous outdated Intergovernmental Panel on Climate Change reports and does not correspond with methane's atmospheric residence time of 12 years. This study is based on the review of 14 peer-reviewed research studies in order to compare the emissions factor estimated in each one along different fossil gas supply chain stages and operations. There are some parameters which define substantial differences, such as whether the extraction is conventional or unconventional, the world region where it is produced and the method of measurement used – "bottom-up" or "top-down". Therefore, the methodology defined in this study considers more than one academic research paper or report in order to evaluate the fugitive emissions generated at each operational stage.

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3 TANAP Environmental and Social Impact Assessment, Chapter 2, page 16, https://bankwatch.org/wp-content/uploads/2018/01/ESIA-TANAP-Chapter2.pdf. At the time of writing, the original file link on the TANAP website (http://www.tanap.com/reference-documents/) did not work.

4 Ibid.

5 Ibid.

6 U.S Energy Administration https://www.eia.gov/tools/faqs/faq.php?id=73&t=11

Global Warming Potential

GWP is a gas-related indicator based on radiative impact and atmospheric residence time. It can include both the direct (when emitted) and indirect (when in contact with other atmospheric components) radiative effect of gas (Shindell et al. 2009). The GWP value of gas specifies how many times more it contributes to global warming in relation to carbon dioxide. The current GWP concept determined by the Intergovernmental Panel on Climate Change (IPCC) is quite limited since it does not take into account indirect radiative effects. Therefore, it is necessary to consider the radiative effects of gases since the greenhouse gas effect is strengthened when they react with certain atmospheric components, such as aerosols.

The timescales evaluated in the IPCC reports are 10, 20, 100 and 500 years, with 100 years the most used timescale at the political level[7][8][9]. This was determined in the international treaties, aiming to standardize the GWP used in order to make the process of decision-making easier (Howarth et al. 2012). It should be considered that the GWP value is higher when the timescale is shorter. However, there are more difficulties in estimating the GWP value for shorter timescales because emissions are related to when and where they are produced (Shindell et al. 2009).

Despite this decision underlying the international treaties, the 5th IPCC report[10] (AR5) states that "there is no scientific argument for selecting 100 years compared with other choices", and that "the time scale choice depends on the relative weight assigned to the effects of different times" (Howarth 2014). The 100 year GWP standardisation implies that emissions generated by other greenhouse gases with shorter atmospheric residence times must be regulated by local- to regional-scale policies targeting air quality (Shindell et al. 2009) . Short

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7 European Investment Bank (EIB) http://www.eib.org/attachments/thematic/short_lived_climate_polluants_report_2016_en.pdf

8 World Bank (WB) http://www.worldbank.org/en/topic/climatechange/brief/pilot-auction-facility-methane-climate-mitigation

9 US Environmental Protection Agency (US EPA) https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

10 IPCC (2013) http://www.climatechange2013.org/images/report/WG1AR5_ALL_FINAL.pdf

atmospheric residence time greenhouse gases are nitrogen oxides (NO_X), sulphur dioxide (SO_2) or ammonium (NH_4).

Nowadays, there is a debate about the GWP timescale because some of the stakeholders taking part in political decisions are in favour of emphasising short-term climate impacts – on a 20-year time scale – whereas others wish to evaluate long-term climate dynamics, in terms of centuries (Sanchez & Mays 2015). In the first case, methane would be the main contributor, while carbon dioxide would be the second one. The contribution of greenhouse gases in each case depends on their atmospheric residence time. Methane's atmospheric residence time is 12 years (Sanchez & Mays 2015), while the residence time for carbon dioxide is in the order of centuries.

In terms of methane's atmospheric residence time, the 20 year GWP time scale is the most appropriate in order to evaluate the contribution of methane to global warming. The methane 20-year GWP determined by the 4th 11 and 5th IPCC reports are 72 and 86, respectively. The results obtained by Shindell et al. (2009) are 79 when direct radiative effects are taken into account, and 105 for direct and indirect radiative effects.

Methane is one of the emissions precursors of tropospheric ozone and black carbon (BC), that are the only two compounds known to cause both global warming and degraded air quality (Shindell et al. 2012). In the case of black carbon, it is not a greenhouse gas and its particles' albedo-related effect makes it one of the biggest causes of the melting Arctic ice cap[12].

11 IPCC (2007) https://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4_wg1_full_report.pdf

12 Wikipedia https://en.wikipedia.org/wiki/Albedo

METHODOLOGY

The gas supply chain operations considered in this study are extraction, transmission and combustion. Extraction and transmission operations have been taken into account because they allow an evaluation of the direct climate impacts associated with the gas transported by the SGC. The fugitive emissions during the drill-out and flowback operations can be considered negligible (0.01 percent), due to the fact that the gas extracted is conventional (Howarth et al. 2011).

The results obtained in the Howarth et al. (2011) and Höglund-Isaksson (2017) studies have been used in order to calculate fugitive emissions in the extraction operation, whereas the Lechtenböhmer et al. (2007) study and the Taglia & Rossi (2009) and IPCC (2006) reports have been considered for the transmission operation.

The transmission infrastructure components treated in this study are: pipeline, compressor station, meter station, regulator station and block valve stations. The quantity of each transmission infrastructure component along the SGC has been obtained from the environmental and social impact assessment (ESIA) of the three pipelines that make up this system of pipelines: SCPX[13], TANAP[14] and TAP[15,16]. The report provides a range of values defined as Low, Medium and High for each component, except for block valve stations. The Lechtenböhmer et al. (2007) study gives the values for the pipeline and compressor station and the Taglia & Rossi (2009) report for the pipeline uniquely, although it distinguishes between onshore and offshore pipelines. The block valve station value has been obtained from the ESIA of the SCPX. The combustion operation calculus has been performed using the International Energy Agency (IEA) World Energy Outlook (WEO) of 2016.

Here, the methodology shown in Höglund-Isaksson (2017) has been chosen, since it is robust and details are clearly described in its 33 page supplementary material[17]. Following its rationale, we assign 0.52 percent as the lower range value of the fugitive emissions in the extraction operation. On the other hand, Howarth et al. (2011) contemplates a scenario where fugitive emissions are much higher (2.35 percent). We select this percentage as the

13 SCPX ESIA http://subsites.bp.com/caspian/CAU/Eng/esia1/Stmnt/chp10/chp10.PDF
14 TANAP ESIA http://www.tanap.com/reference-documents/
15 TAP ESIA (Greece) https://www.tap-ag.com/our-commitment/to-the-environment/esia-greece
16 TAP ESIA (Albania) https://www.tap-ag.com/our-commitment/to-the-environment/esia-albania
17 Höglund-Isaksson (2017) [supplementary material] http://iopscience.iop.org/1748-9326/12/2/024007/media/erlaa583e_suppdata.pdf

upper range value, due to the reliability of the source, being a revision of previous academic research and one of the first critical studies related to the estimation of fugitive emissions by institutional organisations, such as the U.S Environmental Protection Agency. It should be noted that there is no scientific consensus about fugitive emissions produced in extraction operations. Fugitive emissions associated with pipelines located inside the well-pad have been calculated by API (2015). The IPCC (2006) report has been used here because it is a well-known document among researchers, although the value range is quite wide and it does not differentiate between regions and technological development. Lechtenböhmer et al. (2007) relies on an exhaustive analysis of fugitive emissions of Russian transmission pipelines built during the 1970s and 1990s, so the values obtained are high and it is supposed that the current technology can reduce them. Taglia & Rossi (2009) evaluates some Russian and Algerian gas pipelines to Europe. It is the only report providing a factor that takes pipeline pressure into account. IEA (2016) provides the average emission-intensity value for existing Combined Cycle Gas Turbine power plants in 2016: 450 gCO_2/kWh.

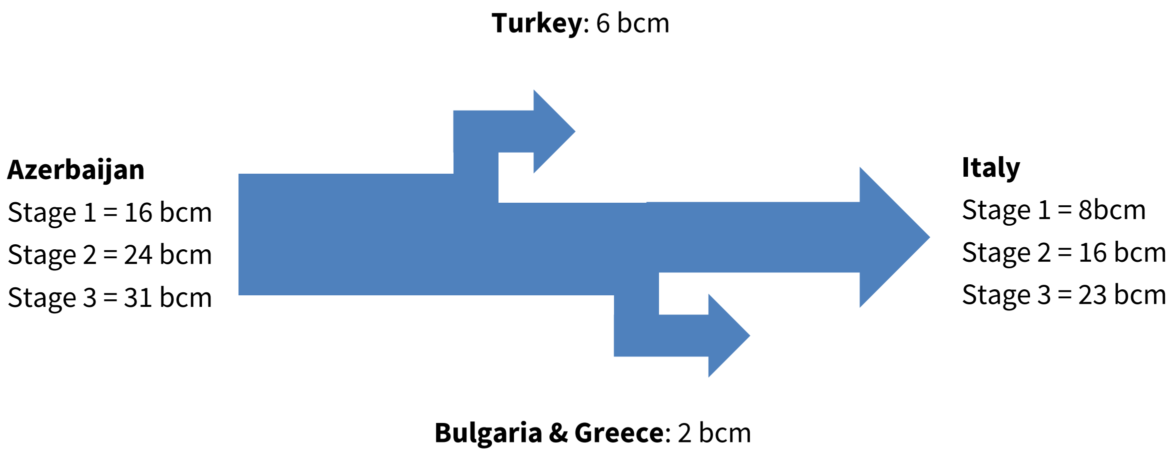
Taking into account the data and values provided in the extraction and transmission operations, nine different scenarios have been generated in this study. Four scenarios consider fugitive emissions determined by Höglund-Isaksson (2017) (sc1 to sc4), four other scenarios consider those estimated in Howarth et al. (2011) in the extraction operation (sc5 to sc8) and one takes into account the fugitive emissions determined in Howarth et al. (2011) in both the extraction and transmission operations (sc9) (see Table 1). In the case of scenario sc9, the full range (low-high) of fugitive emissions produced in the transmission operation has been considered because it is wide and shows the uncertainty over estimating them using a generic approach. Studies assigned to the different components of the transmission operation for the four scenarios for each extraction study are determined in Table 1. Block valve station and combustion stage values are the same in each scenario. The emissions factor estimated in each operation and transmission component by each study or report is also specified.

Table 1: Studies and reports considered in the extraction, transmission and consumption operations for each scenario. For the transmission operation, we include components and associated emissions factors considered in this study and for each scenario.

Scenario	Nomenclature	Extraction	Transmission					Combustion
			Pipeline	Compressor station	Meter station	Regulator station	Block Valve Station	
1	sc1	Höglund-Isaksson [0.52%]	IPCC [1,883 m^3 CH_4/km]	IPCC [18,834 m^3 CH_4/MW]	IPCC [4,709 $m^3 CH_4$/station]		ESIA SCPX [1,089 $m^3 CH_4$/station]	IEA [450 gCO_2/kWh]
2	sc2		Lechtenböhmer [6,458 m^3 CH_4/km]	Lechtenböhmer [49,418 m^3 CH_4/MW]	IPCC			
3	sc3		Taglia & Rossi [1,443 m3/bcm/km]	IPCC				
4	sc4		Taglia & Rossi	Lechtenböhmer	IPCC			
5	sc5	Howarth [2.35%]	IPCC				ESIA SCPX	IEA
6	sc6		Lechtenböhmer		IPCC			
7	sc7		Taglia & Rossi	IPCC				
8	sc8		Taglia & Rossi	Lechtenböhmer	IPCC			
9	sc9		Howarth [1.4% - 3.6%]					IEA

It was assumed that in each stage the Turkish off-takes will receive 6 bcm from the SGC and 2 bcm more will be distributed to Bulgaria and Greece, so Italy will receive 8, 16 and 23 bcm in the first, second and third stages, respectively. The first, second and third stages are planned to start operating in 2018, 2023 and 2026, respectively.

Figure 1: SGC gas input and distribution among countries which take part along it, differentiating between SGC operational stages in the case of Azerbaijan and Italy.



Fugitive emissions associated with the transmission operation of scenario sc9 are calculated considering the gas distributed to countries like Turkey, Greece and Bulgaria. For this reason, the section from Azerbaijan to the Turkey-Greece border is supposed to transport 16 bcm, the Greece section 10 bcm and the Albania-Italy section 8 bcm (See Figure 1). In the case of scenario sc9, it has been distinguished between the lowest and highest range value.

Results

Table 2 shows the annual and cumulative emissions associated with all the scenarios generated in this study. Annual emissions are differentiated between the three operational stages of the SGC, while the cumulative ones are calculated up to 2030 and 2050. The units of measurement used are kilo-metric tons of carbon dioxide equivalent (ktCO_2eq.). It should be noted that the values used are the average range value for each scenario.

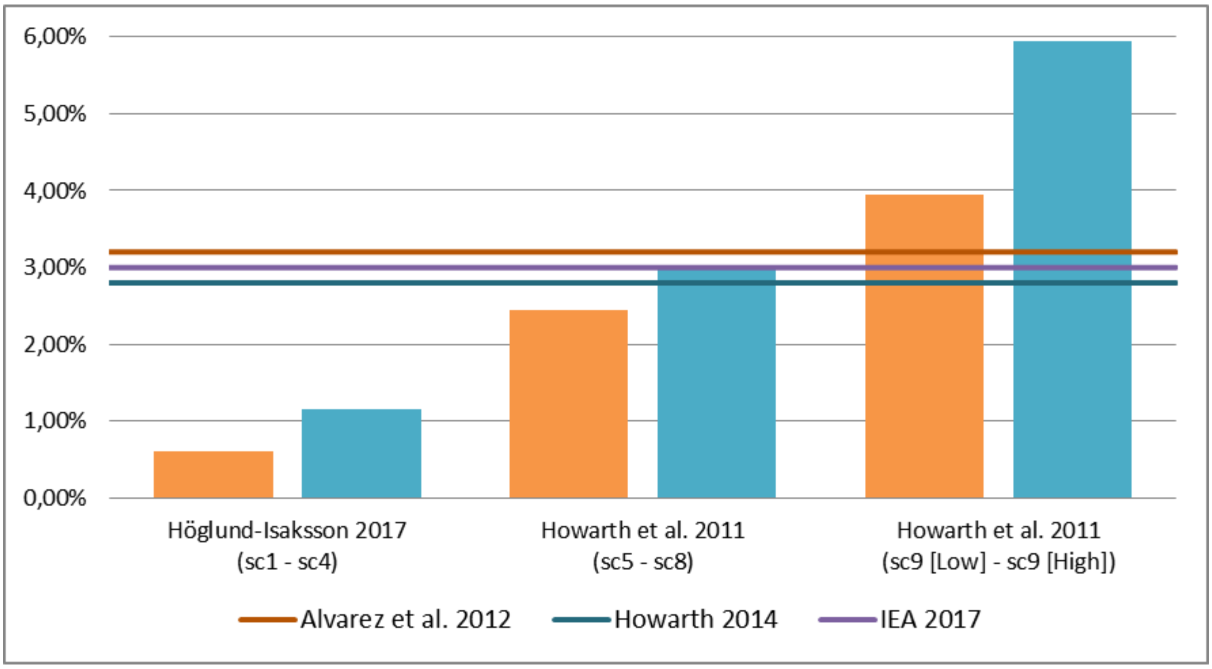
Table 2: Annual and cumulative emissions associated to scenarios sc1 to sc8 in tCO_2eq. Annual emissions differentiate between the three operational stages of the SGC, meanwhile cumulative emissions are up to 2030 and 2050.

		Stage 1	Stage 2	Stage 3	Cumulative 2030	Cumulative 2050
Emissions (ktCO_2eq)	sc1	55.199	97.885	135.019	1.241.716	3.942.096
	sc2	56.814	100.339	137.854	1.274.355	4.031.431
	sc3	58.681	103.502	142.504	1.314.362	4.164.433
	sc4	59.430	105.089	144.472	1.334.778	4.224.223
	sc5	70.766	121.230	165.169	1.543.368	4.846.756
	sc6	72.381	123.684	168.004	1.572.977	4.933.062
	sc7	74.248	126.847	172.654	1.615.050	5.068.130
	sc8	74.997	128.434	174.623	1.633.400	5.125.854
	sc9 (low)	81.184	137.451	186.684	1.751.694	5.485.373
	sc9 (high)	98.858	165.054	222.975	2.104.330	6.563.834

Table 2 shows how the difference in emissions between scenarios is directly related with the extraction operations. Emissions associated with scenarios based on Höglund-Isaksson (2017) are lower than those based on Howarth et al. (2011). Moreover, the difference between fugitive emissions produced during the transmission operation in scenarios sc1 and sc4 is 0.45 percent, which is much lower than that for extraction, 1.83 percent. For this reason, we compare percentages related to fugitive emissions, distinguishing between Höglund-Isaksson (2017) and Howarth et al. (2011), and specifying the minimum and maximum value for each one (See Figure 2).

Extraction and transmission are considered to determine the percentage corresponding to fugitive emissions produced along the gas supply chain. Studies carried out by Alvarez et al. (2012) and Howarth (2014), and the IEA World Energy Outlook of 2017 (IEA2017)[18], establish a limiting fugitive emissions percentage, beyond which gas stops receiving a climate benefit compared to coal. These studies also evaluate extraction and transmission gas supply chain operations. Alvarez et al. (2012) finds this percentage to be 3.2 percent, whereas Howarth (2014) establishes it at 2.8 percent. In the case of the IEA2017, this threshold has been established at 3 percent. Since methane remains in the atmosphere for approximately 12 years (Howarth 2014), climate impact in these studies is determined under the 20 year GWP.

Figure 2: Fugitive emissions percentage for scenarios sc1, sc4, sc5, sc8 and sc9 compared with the percentages when gas stops receiving a climate benefit in relation to coal. In the case of scenarios sc1 to sc8, they will be distinguished considering the study assigned to the extraction operation (Höglund-Isaksson (2017) and Howarth et al. (2011)).



18 IEA World Energy Outlook 2017 (Webinar) http://www.iea.org/newsroom/news/2017/october/commentary-the-environmental-case-for-natural-gas.html

Figure 2 shows that scenarios which consider Howarth et al. (2011) for the extraction operation have fugitive emissions values similar to the thresholds of 2.8 percent and 3 percent estimated in Howarth (2014) and IEA2017, respectively. For this reason, it cannot be affirmed that gas is more climate beneficial than coal. In addition, this comparison allows the confirmation that the result of scaling-up the emissions corresponding to the transmission components are much lower than those estimated by a generic approach. One reason may be that the emissions associated with the different transmission components are measured in gas infrastructure where the industry allows it (Caulton et al. 2014). In this sense, it is important to consider that there is not a scientific consensus on the fugitive emissions generated in transmission operations.

Moreover, percentages corresponding to fugitive emissions obtained in scenarios which consider Howarth et al. (2011) for the extraction operations are close to the 2.8 percent and 3 percent thresholds. Therefore, the precautionary principle[19] should be applied for the SGC project because of the evident risk that it will significantly contribute to increases of greenhouse gas emissions. Furthermore, we have not taken into account emissions and impacts generated by preceding works associated with the construction of the pipeline (i.e., steel production, transport of material and equipment, heavy machinery, excavation and earth moving work and construction waste treatment).

We have compared emissions values for all scenarios generated in this study in each operational stage with the amount of emissions produced by some European countries in 2015, in order to give a proper sense of scale of emissions in $ktCO_2eq$ (see Figure 3).

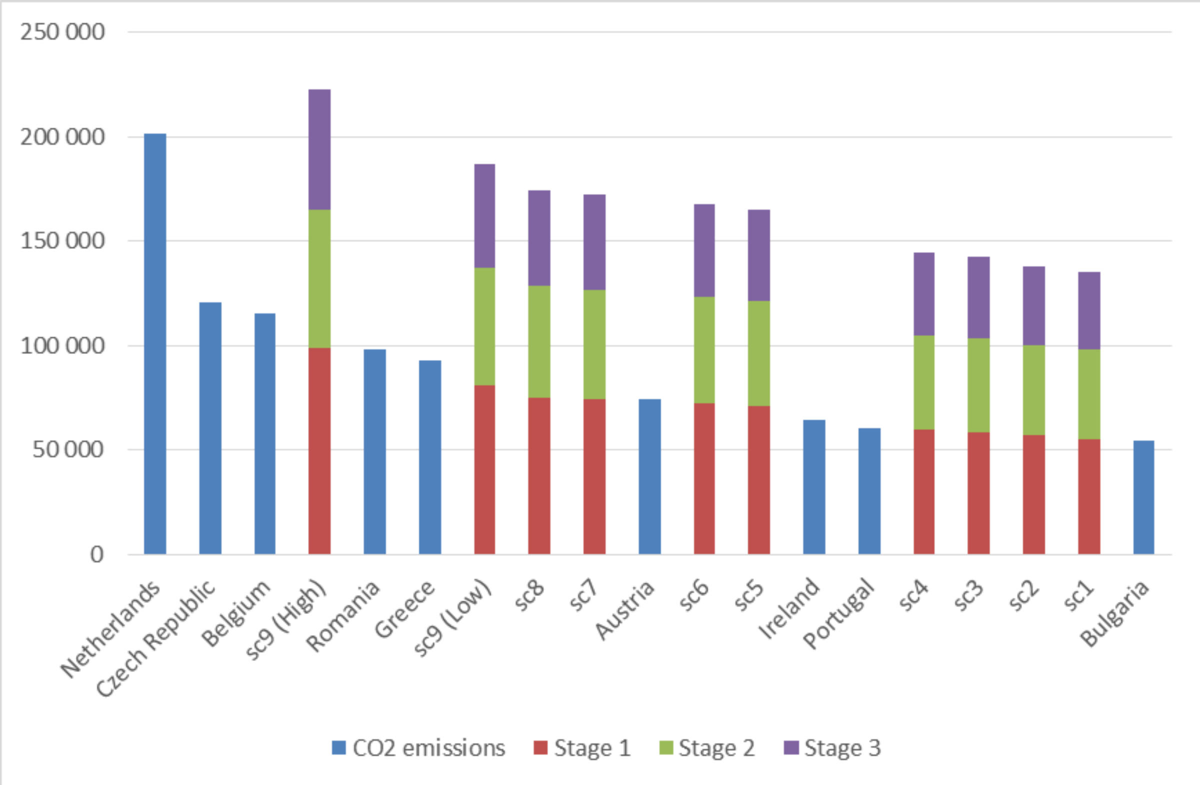
The selection of countries was done in order to represent all the European regions defined by the United Nations (UN)[20] while also choosing countries whose emissions are within the range of emissions for scenarios sc1 to sc9. The countries selected for each European region are: northern Europe (Ireland), eastern Europe (Bulgaria, Czech Republic and Romania), southern Europe (Greece and Portugal) and western Europe (Austria, Belgium and the Netherlands). Countries' emissions have been taken from the Eurostat greenhouse gas emissions database by source sector[21], considering all sectors and indirect carbon dioxide emissions.

19 IPCC precautionary principle http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=437

20 United Nations Statistics Division https://unstats.un.org/unsd/methodology/m49/

21 Eurostat database (env_air_gge) http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_gge&lang=en

Figure 3: Comparison between emissions produced by scenarios sc1 to sc9 in each SGC operational stage and 2015 emissions in selected European countries, in ktCO_2eq.



In stage 1, the annual emissions produced in all scenarios are higher than those generated by Bulgaria (2015). In stage 2, all scenarios generate more emissions than Greece (2015), while the Netherlands' emissions in 2015 are similar to those corresponding to the scenario with the highest emissions in stage 3.

CONCLUSIONS

Taking into account the results obtained in this study, it can be concluded that:

Fugitive emissions values for almost half of the generated scenarios are close to the 3 percent threshold defined by the International Energy Agency (IEA), beyond which fossil gas stops delivering a climate benefit compared to coal[22]. The analysis indicates a high risk that the gas transported by the SGC would be as climate-damaging as coal. Southern Gas Corridor already in its first stage will cause annual carbon dioxide emissions of at least 55 000 ktCO_2eq which is comparable to the annual emissions of Bulgaria.

The range of values between the scenarios generated in this study is remarkably wide, given the lack of scientific consensus regarding fugitive emissions associated with the extraction operation. Moreover, the number of studies which evaluate the fugitive emissions associated with importing European gas pipelines is limited because the majority of them are focused on the USA and China. The scaling-up of fugitive emissions corresponding to the transmission components is much lower than those estimated by a generic approach. In this sense, a scientific consensus about the fugitive emissions generated in the transmission operation does not exist.

“Coal thresholds” must be considered as an inadmissible limit for fugitive emissions produced along the gas supply chain. From a climate perspective, the huge amount of public financial resources and political support for a limited and possibly non-existent differential climate benefit cannot be justified. Therefore, the precautionary principle[23] should be applied for the SGC project because of the high risk of the gas from the project being as climate-damaging as coal. Given that gas is mainly used as an energy resource, low carbon alternatives (i.e., energy efficiency and renewable energy) must be considered instead.

The 100 year Global Warming Potential (GWP) time scale standardisation, as a standard for decision making, restricts the possibilities of evaluating the climate impact of short-lived greenhouse gases. Bearing in mind the current climate emergency, it is important to focus on greenhouse gases which have a significant contribution to global warming in a short-term time span (i.e., methane), and also non-greenhouse gas atmospheric compounds (i.e, black carbon). The 100 year methane GWP value usually used is 25, which was determined in the 4th IPCC report. The methane GWP value used from now on must be based on the 20 year

22 International Energy Agency, World Energy Outlook 2017

23 IPCC precautionary principle http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=437

time scale and updated to the 5th IPCC report, which is 86. The GWP values determined in the next IPCC reports must include greenhouse gases' radiative effects, since indirect radiative effects can increase the methane GWP to 105.

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