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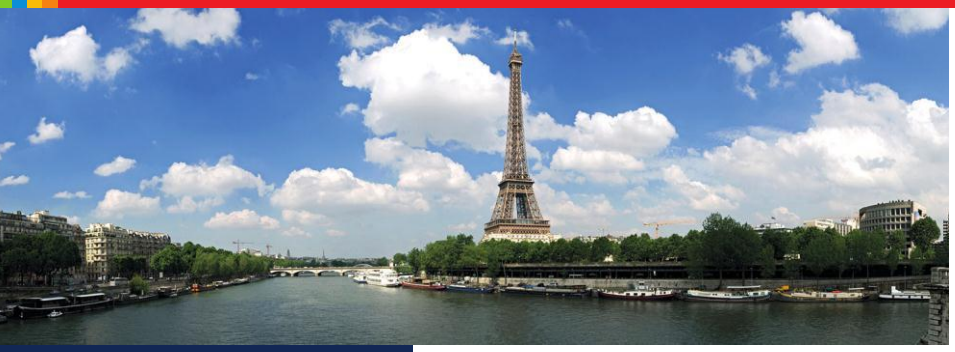

Is natural gas green enough for the environmental and energy policies?

Theme Paper

by

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INTRODUCTION

Climate change policies in line with the objective of transitioning to a lower-carbon world are progressively gaining support amongst policymakers worldwide. In the run-up to the UN Climate Change Conference in December 2015 in Paris, policymakers are intensifying their efforts to agree on a new global framework. The recent agreement between China and the United States and the G-20 meeting in Brisbane in November 2014 underscore these renewed efforts. Because the energy supply sector is the largest contributor to greenhouse gas (GHG) emissions,[1] reworking the current energy supply mix is a priority for policymakers. So far this has resulted mainly in the promotion of low-carbon-emitting energy technologies. However, as part of this strategy, governments are also establishing support schemes for the deployment of renewable energy sources, and in some economies efforts are being made toward higher energy efficiency.

It is widely recognised, at least with regard to existing technologies, that most renewable energy sources in electricity generation need to be backed up by more predictable and stable forms of energy, and fossil fuels often seem to be the unavoidable option. In view of the low-carbon goals mentioned above, it would seem logical that natural gas, as the fuel that produces the most energy per carbon emitted, would be strongly promoted: in combination with investments in renewable energy sources or stand-alone, gas-fired power generation achieves a meaningful reduction in GHG emissions compared to energy mixes that rely mainly on coal, for example.

However, fuel switching for environmental purposes has not yet gained momentum. On the contrary, the last ten years have seen a marked increase in coal-fired generation, which has dwarfed the use of gas-fired generation in some cases and may have even negated the gains from investments in renewable energy. The contribution which gas can make towards reducing global warming by replacing coal in the fuel mix has not been reflected in any firm policies by policymakers.

This paper aims to explain this counter-intuitive development by reviewing the current status of gas as a "clean fuel" in energy policies. It discusses reasons why governments hold back on making gas a centrepiece of their energy policies and examines why the role of coal, the main competitor of gas, has managed to be largely unaffected. The paper concludes with a look at what might lead to a change in the future with regard to the role of gas in a low-carbon economy.

WHAT SUPPORTS THE "CLEAN" IMAGE OF GAS?

Natural gas is a fossil fuel and therefore emits CO_2 when it is burned to produce energy. The claim that gas is green and clean is founded on its environmental properties relative to the other fossil fuels, oil and coal, notably:

- Lower sulphur dioxide (SO_2) emissions, responsible for acid rain,
- Lower nitrogen oxides (NO_x) emissions, responsible for urban smog,

[1] Responsible for 35% of total anthropogenic GHG emissions in 2010, according to IPCC (2014).

- Lower particulate matters emissions, responsible for health and visibility problems, and
- Lower carbon dioxide (CO_2) emissions, responsible together with other greenhouse gases for climate change.

These properties of natural gas offer societal benefits in the more environmentally friendly operation of energy systems, in presenting policy solutions that address local air quality issues, in energy conservation and efficiency, and in containing climate change and supporting the use of intermittent renewable energies.

AIR QUALITY ISSUES

Gas can reduce problems of poor air quality, e.g. smog and particulates, when used in power generation, as an industrial fuel and as a transportation fuel. While Compressed Natural Gas (CNG) is used in passenger and return-to-base commercial vehicles, Liquefied Natural Gas (LNG) also presents a cleaner alternative to the use of oil products for heavy-vehicle road and marine (inland) transport.[2]

ENERGY CONSERVATION AND EFFICIENCY

The low-carbon property of natural gas, meaning that natural gas offers more energy per unit of CO_2 emitted than coal or oil do, is further emphasised by advanced technological developments, i.e. Combined Cycle Gas Turbines (CCGT) and Combined Heat and Power (CHP) plants, with thermal efficiencies of up to 60%[3] and 80%[4], respectively. As a result, the amount of CO_2 emitted per kWh generated by CCGTs is about half of that from coal.[5]

CONTAINING CLIMATE CHANGE

Containing climate change is one the biggest issues for policymakers worldwide. To limit global warming to 2^0C, the world will have to reduce CO_2 emissions and convert rapidly to lower-carbon energy systems.[6] Most man-made emissions today are caused by coal-fired power generation, as capture and storage technologies are simply not commercially or economically available. Since the 1970s coal-fired generation capacities have increased substantially.[7] Coal accounts for 41% of electricity production worldwide and 73% of the total CO_2 emissions of the power sector.[8] Plant lifetimes imply that unless carbon capture and storage (CCS) or other abatement technologies are applied to coal generation plants, CO_2 emissions will remain significant in the coming decades. As gas-fired generation emits half the CO_2 of coal-fired generation, the contribution that gas could make towards a low-carbon environment is thus substantial. The IEA's Golden Age of Gas scenario envisions a situation in which, thanks to a larger consumption of natural gas, it is possible to achieve an overall reduction of CO_2 emissions, even with an increase in the share of fossil fuels in the energy mix.[9] Actually, with a total replacement of coal by gas, gas could play its role in full and global

[2] Nijboer, M. 'The Contribution of Natural Gas Vehicles to Sustainable Transport', IEA Working Paper, 2010, see: http://www.iea.org/publications/freepublications/publication/the-contribution-of-natural-gas-vehicles-to-sustainable-transport.html

[3] Technology Brief E02, IEA ETSAP, 2010, see: http://www.iea-etsap.org/web/e-techds/pdf/e02-gas_fired_power-gs-ad-gct.pdf

[4] United States Environmental Protection Agency (EPA) website, see : http://www.epa.gov/chp/basic/efficiency.html

[5] IEA Statistics, 'CO_2 Emissions from Fuel Combustion, Highlights', IEA 2013.

[6] Overview of responses to climate change: http://unfccc.int/essential_background/items/6031txt.php

[7] BP 2013.

[8] IEA, 'World Energy Outlook 2013'.

[9] IEA, 'Are We Entering a Golden Age of Gas?', Special Report, World Energy Outlook 2011.

warming would remain within its budget, as illustrated in Figure 1 below, in which the current proven stack of coal, oil and gas reserves is intersected by a 2^0C carbon budget line.[10,11]

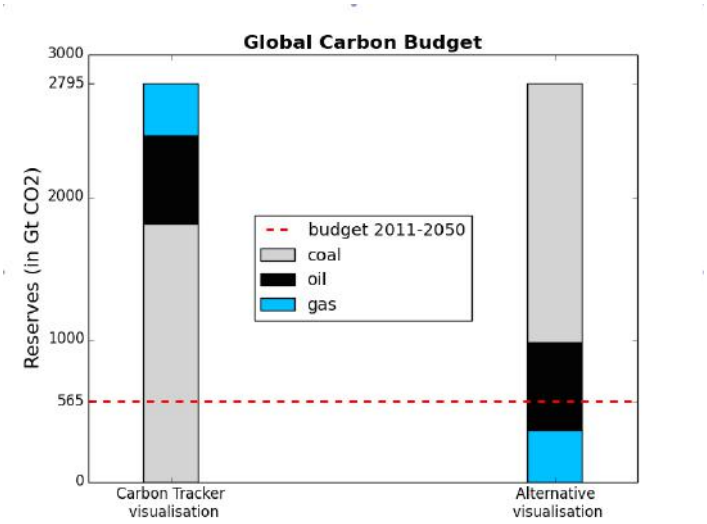

Figure 1: Remaining carbon budget through 2050 relative to total proven fossil fuel reserves (in a 2^0C scenario) – alternative visualisations. Source: 'Transition? What Transition?', CIEP 2014.

GAS AND RENEWABLES

In addition to its much lower emissions, the short response time of a CCGT plant relative to that of a coal-fired plant makes natural gas the most suitable fuel for complementing renewable energy systems (RES), both operationally and at the lowest environmental costs. These combinations can be delivered as integrated solutions for centralised energy systems as well as for decentralised systems, e.g. for the residential market, where solar applications are becoming increasingly available. On these grounds, natural gas can act as a companion fuel to renewables and play a key role in the transition to a low-carbon energy system.

TO WHAT EXTENT DO CLIMATE CHANGE POLICIES FAVOUR THE USE OF GAS?

The objective of this section is to understand why natural gas does not seem to be finding its place in public policies that promote the transition to a low-carbon economy. Energy and environmental policies adopted worldwide have devised a number of ways to promote natural gas, but it seems that current policies may at best be advantageous for gas in the long run. The question remains as to why the virtues of natural gas are not reflected more consistently in policy.

CLIMATE CHANGE MITIGATION POLICIES

Climate change mitigation policies have been implemented as part of UN negotiations, and now also increasingly as part of stand-alone domestic policies. While some jurisdictions have attempted to put a price on carbon, for instance with Emission Trading Schemes (ETS) or carbon taxes, others have used environmental standards. These instruments have been adopted worldwide to direct

[10] Carbon Tracker Initiative, http://www.carbontracker.org/our-work/

[11] In most presentations on energy, bar diagrams show coal at the bottom and natural gas at the top, creating the false impression that only a radical departure from the fossil fuel energy economy would fit within a low-carbon future. However, such a presentation obscures the fact that natural gas does fit within a low-carbon future, as long as the carbon budget is not 'eaten up' by less efficient fuels per carbon emitted when left in the mix without abatement technologies.

investments towards energy efficiency and less-emitting energy sources and technologies. One key expectation was that these instruments, and carbon markets in particular, would encourage the switch from coal to gas in power generation, but shortfalls in the functioning of such markets under all economic circumstances prevented this switch from materialising. The schemes have often failed to interact properly with dynamic inter-fuel competition and changing energy demand.

Carbon pricing mechanisms have had a wide roll-out...

The EU ETS is the world's largest carbon market, covering 2 billion tonnes of GHG, though it only accounts for 4% of worldwide GHG emissions. Outside Europe, large emissions trading schemes are in operation in the USA and Canada (in California; and through the Regional Greenhouse Gas Initiative, or RGGI[12], which gathers states and provinces of the Northeastern US and Eastern Canada) and in China (seven regional pilots are in place, and plans exist to establish a nation-wide market in 2016). In total, 39 countries and 23 sub-national jurisdictions have adopted carbon pricing mechanisms, mainly in the form of ETS or carbon taxes.[13] According to the World Bank, carbon pricing instruments cover approximately 6 gigatons of carbon dioxide equivalent, corresponding to 12% of the annual global GHG emissions.[14] By 2020, it estimates that trading schemes will cover more than 40% of global emissions, equivalent to 19 billion tonnes.

...with various degrees of momentum...

Although originally designed as free market-based mechanisms, carbon markets have often been framed by their opponents as examples of governmental interference in the economy. As a result, multiple cap-and-trade schemes have lost momentum after becoming embroiled in larger political disputes about the size and role of government and the impact on the local or global economy.

> Major coal-based emitter Australia is a recent example of a significant shift in domestic climate change framework. Australia's carbon pricing mechanism, using a three-year fixed carbon price from 2012 to 2015, was to be linked with the EU ETS. However, the scheme was repealed after a Senate vote in July 2014, where the Liberal Party gained support for new job creation and economic growth priorities.[15] The carbon tax was considered a burden for the competitiveness of the industry and is about to be replaced by a new scheme, the Emissions Reduction Fund, which will allocate funding to private sector initiatives for emissions reductions.

> In Europe, the ETS remains the centrepiece of climate policy, as confirmed by the European Council on 23rd/24th October 2014, but there are a lot of concerns surrounding the current surplus of allowances on the market. A reform is underway for the 4th phase of implementation starting in 2020. The scope of application of the EU ETS is also a difficult

[12] Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island and Vermont. The RGGI programme was established in 2009.
[13] World Bank, 'States and Trends on Carbon Pricing', May 2014.
[14] *Ibid.*
[15] http://www.environment.gov.au/climate-change/repealing-carbon-tax

topic. The integration of air transport into the ETS was delayed due to disagreement between the EU and the International Civil Aviation Organization (ICAO). In September 2013, the ICAO stated that it would propose a market-based mechanism to reduce GHG emissions from international aviation by 2016 and implement it by 2020.[16]

…that are not effectively promoting low emission energy sources.

Affected by the over-supply of emission allowances relative to final emissions, as well as weak underlying quota demand, the EU ETS, a flagship for European climate policy back in 2005, has been caught in a trap, failing to generate a clear price signal for effective emission abatement. In the US, California's emission budget trading programme and the RGGI have not managed, either, to really raise carbon prices towards initial expectations, as the schemes are protected by price caps. All in all, the efficiency of using market-based carbon emission trading schemes has so far been disappointing.

Given the challenges raised by the ETS, Environment Performance Standards (EPS) have been used as an alternative or sometimes-complementary regulatory tool. EPS impose a direct burden on the emissions or other environmental externalities of an industrial facility (refinery, power plant, waste facility, etc.). The oldest and most famous standards are applied by the US Environmental Protection Agency (EPA).

The Environmental Performance Standards as an alternative tool?

Around the world, EPS is used as an alternative means of lowering (or mitigating) emissions and is applied in different sectors, with a strong focus on the power generation and manufacturing industry.

The jury is still out regarding the impact of the new rules proposed by the EPA for reducing CO_2 emissions from power plants, which are a key part of President Obama's Climate Action Plan.[17] The rules are to be finalised by the end of 2015. First, they introduce separate emission standards for new coal- and gas-power plants. Second, the EPA proposes to set an emissions target for each state to cut 30% of the power sector's carbon emissions by 2030 compared to the (relatively high) base year of 2005. Implementation is flexible, and each state will have to choose a combination of tools to reduce the emissions of its power sector. In 2014, the UK introduced an EPS equivalent to 450g/kWh at base load as an annual limit on carbon emissions from new fossil fuel plants.[18] Discussions are also surfacing for a "coal phase-out" in Germany, after the nuclear phase-out plan, which may lead to introducing EPS. In December 2014, the Cabinet agreed on a new climate action plan to reach emissions reduction targets for 2020. The power sector will be required to lower its emissions by 22

[16] Parth Vaishnav, Department of Engineering and Public Policy at Carnegie Mellon University in Pittsburgh, 'Issues in Science and Technology', 2014.

[17] Executive Office of the President, White House, 'The President's Climate Action Plan', June 2013.

[18] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/357217/implementing_emissions_performance_standard.pdf

million tonnes of CO_2, and the plan refers to the submission of a draft regulation on this topic in 2015.[19]

Environmental standards clearly have the potential to value emission abatements in the power sector and therefore favour gas plants over coal plants. However, the standards are not widely applied around the world, and today their implementation focuses on new-built power plants, such that the impact in the medium term is limited. In addition, it is only by setting a unique standard for all emitting technologies that the environmental benefits of gas can be properly valued.

To conclude, there are several uncertainties surrounding the implementation of climate change policies. Despite the focus on climate change, most of these policies have not led to the favouring of the least polluting fossil fuel, such as natural gas. Nevertheless, the environmental benefits of natural gas are emerging in local policies, notably those dealing with air pollution.

CLEAN AIR POLICIES

In addition to climate mitigation policies to reduce CO_2 emissions, other policies also favour natural gas when aiming to improve air quality by reducing emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matter. Most air quality policies are applied at the local level (cities), while some are applied at the national level. The latter generally use GHG emission standards to target pollution sources, sometimes specifying certain segments (such as road traffic and industrial activity).

Adoption of natural gas in urban policies…

In recent years, concerns and awareness about pollution-related health problems have been constantly growing. Many regions and cities around the world have developed and reinforced air pollution policies. A virtuous cycle of growing awareness and policy development is setting the stage. Just a few examples are sufficient to illustrate this trend:

> Japan was one of the first countries in which cities chose gas for reasons of air quality.[20]
>
> Istanbul is another example of a city that suffered from poor air quality and that currently boasts “clean skies” through the massive fuel switching effort to natural gas.
>
> According to Greenpeace,[21] almost 92% of Chinese cities surveyed have air pollution concentrations that exceed the national standard.[22] Six years after the 2008 Olympics, the city of Beijing declared a ban on coal-generation in 2020, giving priority in heating and electricity generation to natural gas.[23] In the Chinese Air Pollution Control Plan, 60% of new vehicles will have to be based on low-emitting fuels, which provides a strong potential to CNG/LNG vehicle transport in the run-up to 2020. Likewise, coal consumption is to be

[19] Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMUB), 'Aktionsprogramm Klimaschutz 2020', December 2014.
[20] Tokyo Gas, 'Developments Up To the Adoption of LNG - Tokyo Gas Looks to the Future', Unofficial Translation by the Japan Gas Association (1990).
[21] http://www.greenpeace.org/eastasia/news/blog/bad-to-worse-ranking-74-chinese-cities-by-air/blog/48181/
[22] 35 microgrammes per cubic metre.
[23] City’s Municipal Environmental Protection Bureau.

reduced in three regions of China that are densely populated and directly affected by air pollution.[24]

In 1998, the Indian Supreme Court enforced the conversion of the country's diesel-powered buses to CNG. In May 2014, the World Health Organisation sounded the alarm when it ranked Delhi as the city with the worst air quality, even overtaking Beijing. Since then, Delhi has introduced various measures to reduce air pollution, including the removal of old vehicles from the road.[25]

In 2009, Mexico City also embarked on a comprehensive air quality management programme, leading to a reduction in CNG fuel prices.[26]

…and in the transportation sector…

The governing bodies of the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO), which represent developing and developed countries, together with the international transportation industry, have acknowledged the need for a mandatory global mechanism to curtail the growth of GHG emissions in their respective sectors, which has accelerated in recent years (+2% p.a. 2010-2012, as tracked by global oil consumption[27]).

Natural gas has begun to challenge oil as the dominant transport fuel, with companies building gas-powered ships and installing networks of service stations on water and land. Expectations for cheaper gas and tighter environmental regulation have created demand for a cleaner alternative to the oil-based fuels that have so far dominated the transport world. Germany, Singapore and the Netherlands are among the countries investing in natural gas transport hubs. Energy consultancy firm Wood Mackenzie mentioned that global gas demand in the transport sector could grow from under 5 bcm in 2012 to over 160 bcm by 2030.[28]

…and as international bunker fuel…

The use of LNG as shipping fuel is also gaining interest, with the introduction of new regulations limiting emissions for ships berthing in ports. Since January 2005, coastal Emission Control Areas (ECAs) have been settled in the Baltic Sea (2006), the North Sea (2007), the US and Canada (2011) and the US Caribbean (2013)[29]. As of January 2015, the sulphur content of marine fuels is limited to 0.1%, and the International Maritime Organization (IMO) now aims at reducing the sulphur content limit from 3.5% to 0.5% in areas outside ECAs. On the basis of such developments, LNG can play a larger role in the maritime sector, on the condition that investments are triggered for both LNG-

[24] Sylvie Cornot Gandolphe, Ifri Note, 'The Chinese Gas Strategy: Challenges and Policy Responses', December 2014.
[25] *The Guardian*, 'Indian Court Slams Delhi's Worsening Air Pollution', 27/11/2014.
[26] United Nations Environment Program, A.T.M. Nurul Amin, October 2009.
[27] PBL Netherlands Environmental Agency - Joint Research Center, 'Trends in Global CO_2 Emissions: 2013 assessment report'.
[28] Wood Mackenzie, 'Global gas demand in the transport sector could grow to over 160 bcm', Press release, 29 January 2014.
[29] Adamchak and Adede, 'LNG as Marine Fuel', 2013.

powered vessels and refuelling infrastructures. The share of LNG in total bunker fuel use is expected to grow gradually and reach 10% by 2040.[30]

At this stage, because air quality policies focus on wiping out the biggest polluting sources in specific sectors, they appear more directly favourable to natural gas compared to policies addressing the environmental performance of the overall production system. This does not mean that climate policies cannot promote the use of natural gas, but it can only be the case if higher ambitions are formulated for technology-neutral emission reduction objectives, translated for instance in a well-functioning carbon pricing mechanism or strong EPS for the new and existing power fleet.

WHY IS GAS NOT GIVEN CLEAR RECOGNITION IN CLIMATE CHANGE POLICIES?

While there are strong arguments for promoting the role of gas in a long-term strategy towards decarbonisation, they do not seem to be receiving widespread recognition. While environmental policies are strengthening, they so far have not translated into a significant shift from other fossil fuels to gas. This may mean that gas does not have a sufficiently positive image for it to be considered a favoured option. The challenge is therefore to understand what the arguments against the use of gas are and to assess whether they are based on real facts.

GAS IS TOO POLITICAL (OR IS PERCEIVED TO BE)

The international gas business is probably more "political" than that of other fuels. One reason is that the nature of the gas business is traditionally "point-to-point", often physically linking producers and consumers. Pipelines, which carry more than two-thirds of the gas traded globally, are inflexible infrastructures that create long-lasting bonds of dependence. By contrast, oil is a freely traded commodity worldwide, while coal exports appear to be generally regarded as politically neutral by the main importing countries. The perception of gas as a politicised commodity may overshadow its environmental benefits. In general, countries seek to limit their dependence on energy supplies from any single country by diversifying their imports or by relying on domestic resources.

> Spain, which satisfies its natural gas demand in large part by pipeline imports from Algeria, has adopted government regulations that limit the percent of total gas volumes any single country may sell to Spain.[31]
>
> China has taken care to build up a portfolio of several gas suppliers (including Myanmar and Turkmenistan), instead of relying solely on Russian gas. China has also chosen to rely extensively on domestic resources, such as coal, to fuel its economic growth, while it is also keen to develop its shale gas potential.

Supply disruptions are a threat particularly for gas-importing countries, and indeed there have been a few such cases. Abrupt political or economic changes in producing countries may impact their export flows, as Chile experienced in 2005 when Argentina cut gas exports to Chile due to supply shortages experienced domestically. Producing countries that are affected by civil war, such as Libya recently, also pose supply risks. Other forms of conflict, such as territorial disputes in the Caspian Sea

[30] IEA, 'World Energy Outlook 2014'.
[31] Up to a maximum of 50%, see Royal Decrees 1716/2004 and 1766/2007, *Official State Journal*, B.O.E. No. 312, 29 December 2007.

region, may similarly increase security of supply concerns by importers. Natural gas supplies may also, indirectly, play a role in the wider political context. Gas can become caught in the middle of various political tensions between countries.

> Recently, the different foreign policy stances of the EU and Russia on the Ukrainian conflict instigated political discussions in the EU aiming to reduce the dependence of Member States on Russian gas imports. Political tensions between Turkmenistan, Afghanistan, Pakistan and India may similarly affect the multilateral cooperation needed in the region to construct the Trans-Afghanistan pipeline (TAPI).

Besides these political risks, the direct role and influence of governments in the natural gas sector also contributes to the political character of gas. National Oil Companies (NOCs) control the majority of the natural gas reserves worldwide,[32] which leads to gas being perceived as a more politically traded commodity. Due to the fact that traded gas is mostly transported through pipelines, also internationally, inter-company gas trade requires government collaboration. Governments of producing countries may also require the official involvement of governments of consuming countries and *vice versa* before business can be done at the private company level, as is for example the case in Turkmenistan[33].

In sum, security of supply and demand concerns may overshadow the environmental benefits of natural gas. It is important to keep in mind that producing countries may similarly worry about the politics of consuming countries. Indeed, security of demand concerns by external suppliers such as Russia and Qatar, faced with two decades of EU market reform and policy change, contribute as much to political discomfort as security of supply issues do in importing countries.

Perceptions or reality?

While the perception that politics and gas are intrinsically linked is vivid, real-life examples of cases in which gas deliveries from one country to another have actually been disrupted are fairly limited. There are in fact numerous cases in which natural gas pipeline cooperation and gas trade has been possible even between political adversaries.

> The scars left on Algerian-Moroccan relations due to political difficulties over the Western Sahara conflict did not prevent them from building the Maghreb-Europe pipeline to bring gas to the Iberian Peninsula from 1996 onwards.

> Soviet gas reached West Germany already in the early 1970s and expanded rapidly to other Western European countries in the 1980s.

[32] 'Today national oil companies (NOCs) control approximately 90 percent of the world's oil reserves and 75 percent of production (similar numbers apply to gas)' in Tordo, S., Tracy B.S. and Arfaa, N., 'National Oil Companies and Value Creation', World Bank Working Paper n.218, 2011.

[33] In negotiating the conditions for exporting gas to the EU, Turkmenistan reiterated its preference for one large, long-term contract with Europe rather than contracts with single companies, see Nyman, K., 'Caspian Development Corporation, Joint Gas Purchasing and Infrastructure Development', The World Bank, presentation given at the Ljubljana Gas Forum in 2009.

Furthermore, countries entrenched in territorial border disputes have shown that cooperation in the energy sector is still possible. All over the world many so-called "joint development" agreements exist in which countries decided to put aside – if temporarily – their border disputes for the sake of jointly exploring and/or exploiting hydrocarbon reservoirs that lie across a disputed boundary (e.g. Malaysia and Thailand in the Gulf of Thailand, the Netherlands and Germany in the Eems Estuary, the UK and Argentina in the waters surrounding the Falklands islands).

> From the moment Japan adopted a diversification strategy away from oil and to natural gas in its energy mix, the Japanese government has maintained especially good relations with its foreign gas suppliers.[34]
>
> While the EU and Russia continue to have their disagreements on a variety of foreign policy issues, Russian gas supplies to the EU have been stable for decades and the EU has become by far Russia's biggest gas trade partner. Shared economic interest in the gas trade may have prevented escalation of these foreign policy conflicts. Along this line of thinking, one could wonder how the current EU-Russia crisis over Ukraine might have deepened if certain European economies had not been so dependent on Russian gas, and likewise, if European exports had not been so beneficial to the Russian economy.

Ultimately, the political perception of gas tends to overshadow the fact that economic interdependence on energy imports and exports can actually promote stable relations between countries as well, since the costs of deterioration are high. Finally, political concerns are particularly related to pipeline gas trade. This entails that some consuming countries aim to reduce their dependence on pipeline gas. However, when serving the purpose of creating more interconnections and integrating different consuming markets and supply sources, the construction of new pipelines is actually beneficial to security of supply. LNG, transported by ship, is considered less subject to politics than pipeline gas, although some maritime transport bottlenecks exist, and the share of LNG in natural gas trade is growing. Independent LNG traders are emerging as new players in global gas trade, contributing to the globalisation of flows. Additionally, liberalisation and the move towards interconnected gas hubs are beneficial to security of supply by allowing more gas sources to spread throughout the network and to compete against one another, thus reducing the exposure of the consuming areas to supply risks.

GAS IS SEEN AS "TOO" EXPENSIVE

Another reason why consuming countries may be reluctant to formulate gas-friendly policies is that this fuel is viewed as being "too expensive". The market segment in which gas is primarily too expensive is power generation. Gas is not cost-competitive in power generation relative to coal (except in gas-producing countries). Without an explicit economic value for its environmental properties, by means of a meaningful CO_2 price, the costs of generating power from gas-fired power plants are higher in most economies than from coal-fired plants.[35] For new-built plants the question of competitiveness is more complex: a gas-fired plant can be built at considerably lower capital costs,

[34] See e.g. J.H. Chrisstoffels, 'Japan: Nieuwe agenda voor energieveiligheid', *Internationale Spectator*, August 2007 (in Dutch).

[35] The difference in costs can also be seen as the costs of changing the existing merit order and hence as a measure of the minimum price of CO_2 needed for the market to reduce emissions.

but its fuel costs remain higher than those of a coal-fired plant. The economic choice will depend on expectations for gas and coal prices, operating hours and CO_2 price. Promoting gas at the expense of coal (for power generation) would thus come at a cost. Given the brittle state of many of today's economies and the importance of competitiveness, this is a price which countries are reluctant to pay, particularly in the absence of a firm, global agreement on CO_2 emissions reduction. Altogether, in many countries gas cannot compete with coal as long as the "green properties" of gas are not valued accordingly through policies, for instance by means of CO_2 prices.[36] Since the CO_2 prices are currently (too) low, emission trading systems are not serving the purpose of discouraging the use of coal for power generation. In most gas-producing countries, natural gas prices are competitive. The irony is then that the United States, which did not ratify the Kyoto protocol, is seeing its greenhouse gas (GHG) emissions reduced through cheap gas, while in Europe, which was the first to put in place an Emission Trading Scheme (ETS), the switch from gas to coal-fired generation has been arrested and sometimes even reversed.[37] Finally, since the global gas market does not have a transparent price benchmark as exists for oil, the views of producing and consuming countries on what is the "fair value" of gas may not necessarily correspond.[38] This could result in disagreements on pricing mechanisms,[39] delay in imports and reputational damage for gas, and possibly in policies aimed at limiting dependence on gas rather than promoting gas as a green fuel.

GAS IS PERCEIVED TO BE NOT GREEN

Despite being the lowest-emitting fossil fuel with clear advantages as a backup for renewables, the perception of gas as a "clean" fuel is hindered by various hurdles.

Gas is part of the problem...

The main focus of politicians is to attempt to back out of fossil fuels in general by means of investments in renewable energy sources (RES). They do not want to be seen promoting a strategy towards a low-carbon economy in which a fossil fuel features by design. The fact that the emissions from gas are considerably lower per unit of energy than those of other fossil fuels is a finesse, which does not detract from the fact that all fossil fuels contribute to climate change and should be phased out sooner rather than later. To the extent that fossil fuels will still be needed to support the variable nature of RES in particular is an unpleasant necessity which should be dealt with urgently. Accepting scenarios that demonstrate that fossil fuels will continue to play a significant role is deemed not politically prudent.

...and its carbon footprint does not make gas any better than other fossil fuels...

Backed by the UN's efforts to mitigate climate change, the Climate and Clean Air Coalition estimates that over 8% of total worldwide natural gas production is lost annually to venting, leakage, and

[36] High CO_2 prices also raise cost of gas, which may make nuclear and renewables (on-shore and solar) more competitive.
[37] 'Gas to Coal Competition in the U.S. Power Sector', International Energy Agency Insight 2013.
[38] Producing countries are interested in extracting the full rent of their gas resources, which may lead to a price that is not regarded as affordable by the consuming countries.
[39] This has notably been the case in Europe, especially since 2008-2009. While hub prices responded to the contraction in gas demand experienced in that period, the price of gas in long-term (largely oil-indexed) import contracts did not adjust automatically. This led to an intensification in long-term contract renegotiations and arbitrations between European importers and suppliers. As of 2014, the gap between prices at the hub and prices in long-term contracts has largely been closed in Northwest Europe, but not in other parts of Europe.

flaring.[40] According to the coalition, these activities result in a nearly 2 Gt of CO_2 equivalent of GHG emissions per year,[41] of which over 80% are methane emissions. They consider oil and gas operations to be the second-largest source of global anthropogenic methane emissions, after agriculture.

Particularly the emissions of methane are a matter of great concern. Methane contributes much more to global warming than CO_2. In its 5th assessment report, the Intergovernmental Panel on Climate Change (IPCC) significantly increased the Global Warming Potential (GWP) of methane: by 36% for 100 years' duration in the atmosphere and 20% for 20 years' duration.[42]

The fact that by far the most flaring (and probably also venting) of gas occurs in connection with oil production, where gas is often an unwanted by-product, does not mean that the gas industry is not held accountable for the problem.

...and unconventional gas production makes it worse...

The evaluation of GHG emissions linked to unconventional gas production is the subject of a number of conflicting studies. Depending on several factors, GHG emissions of shale gas relative to its energy content can be considered as low as those of conventional gas transported over long distances or as high as those of hard coal over the entire life cycle from extraction to combustion. Proponents of gas highlight unconventional gas's lower GHG emissions in comparison with coal,[43] while in other research scientists state that the impact of unconventional gas on climate may be on par with or may even exceed those of coal emissions. They argue that gas is "bad", mostly due to large fugacious methane emissions from hydraulic fracturing processes.[44] Project-specific emissions might vary up to a factor of 10, depending on the specific methane production of the well. This wide range of estimates explains how gas can be negatively perceived: from "very bad" to "mildly bad" when compared in a life cycle emissions analysis[45] and depending on how similar the figure is to that of coal emissions.

The abovementioned studies were based on the 4th assessment report of the IPCC in 2007. The increased estimates made by the IPCC in 2013 of the Global Warming Potential (GWP) of methane for the future increased emissions factor per energy content of this unconventional gas, creating additional concerns that gas performs "badly", especially relative to coal.[46] The emissions due to methane intrusion of aquifers have not yet been assessed but are also of concern to a number of scientists.[47]

[40] http://www.unep.org/ccac/Media/PressReleases/WorkingtoReduceMethaneandBlackCarbon/tabid/131810/language/en-US/Default.aspx

[41] Out of a total 35 Gt estimated CO_2 global emissions.

[42] IPCC AR5, Working Group I, 'The Physical Science Basis - Final Draft Underlying Scientific-Technical Assessment', September 2013.

[43] IEA, 2012; Burnham et al., 2011.

[44] Wigley, 2011; Hultman et al., 2011; Howarth et al., 2011b, Pétron et al. 2012; Pétron et al. 2013.

[45] Existing assessments give a range of an 18 to 23 g CO_2 equivalent per MJ45 from the development and production of unconventional natural gas.

[46] IEA, 'Shale Gas Greenhouse Gas Footprint Review', http://ieaghg.org/docs/General_Docs/Reports/2013-TR1.pdf

[47] European Parliament, DG for International Policies, 'Impact of Shale Gas and Shale Oil on the Environment and Human Health', 2011.

...and because it may hinder the transition to sustainability!

The "shale revolution" in the US has turned gas there into a very affordable commodity. Despite the positive effect this has had on CO_2 emissions as a result of the switch from coal to gas in power generation, some fear that the availability of this abundant and cheap commodity may slow down the transition to renewables.[48] Their concern is first that cheap gas pushes energy consumption up and makes it harder to justify energy efficiency efforts. Second, there is a fear that abundant gas is not the perfect "companion fuel" for renewables but rather a competitor which prevents them from gaining market share.

A related argument is that the world already has more gas reserves than it needs to support the transition. Any political support for shale gas development could thus be construed as moving in a direction that detracts from the necessary focus on the low-carbon economy. Similarly, the development of new gas reserves in environmentally vulnerable areas (e.g. the Arctic) raises concerns and is considered unnecessary.

GAS IS NOT ON THE POLICY AGENDA FOR DOMESTIC REASONS

National energy policy dialogues are sometimes difficult to read and apprehend. "Not in my backyard" reactions can pit citizens against privately or publicly sponsored wind farms projects, as well as against shale gas exploitation. Similar reactions may also come up in national policy debates, where opposition to specific energy sources can be voiced (example: the nuclear debate in Japan), which can at some point give the impression that governments find it difficult to strike the right balance between different priorities and goals. So, why is gas not prioritised at the domestic level as being a "clean" energy source?

Domestically, the lack of enthusiasm to favour natural gas can be traced backed to the necessity to maintain a level playing field between different energy sources, so as not to close down energy policy options and to keep options open to engage in new routes (example: the exploitation of shale gas in Europe). As a result, governments are trying to promote a transition on the basis of instruments like ETS or EPS, rather than systemically supporting one fuel's advantages relative to the others.

More fundamentally, reasons why gas is not broadly advocated at a domestic level cover various energy sovereign sensitivities, including sovereignty over energy resources and the diversity of the energy mix, or more national priorities (protectionism in the coal industry). In most regions of the world, "diversification" is a key common denominator in energy policies, which means that the energy mix should reflect a balance between different sources of energies, in view of increasing national energy independence, and should also reflect a balance between domestic and imported sources. In addition, domestic-specific choices also need to remain consistent with national priorities like employment, protectionism and specific local environmental constraint.

Preserving employment in domestic energy resources (e.g. coal miners in Germany and Poland) can incentivise governments to domestically favour the development of coal compared to natural gas sources. This is a way of leveraging political goodwill in some specific circumstances or certain regions, like regional inequalities, elections or crises (such as Ukraine vs. Russia). In the longer term,

[48] See, for example, McJeon et al., 2014.

protectionism may also allow countries to avoid being exposed to international gas market instabilities or to the nuisance of the power held by transit countries (see the above section 'Gas is too political').

WHY DOES COAL CONTINUE TO GROW?

Looking at the growing concerns about environmental issues and the poor performance of coal in this respect, it would make sense to discourage its use, at least until abatement technologies are more economical, but coal consumption remains on the rise. The key question is why coal is doing better than gas, despite being the most polluting of all fossil fuels.

COAL HAS MAINTAINED A SUBSTANTIAL POSITION WORLDWIDE…

In most regions, coal has been and will continue to be the dominant fuel for power generation.[49,50] In Section 3 we discussed four groups of reasons why gas may not be politically favoured. Reflecting on these reasons in connection with coal, coal is benefitting from a number of factors:

- There is a preoccupation about the (geo)political nature of gas trade, while coal is not perceived to be (geo-)political. It is traded internationally by ship, and most of the source countries are considered politically neutral. The US's and Russia's exports of coal do not play a dominant role in any market. Coal is therefore perceived as being a secure supply source of energy.
- Coal is price competitive (not expensive), relative to gas, as long as the environmental externalities, such as CO_2 emissions, are not priced properly. Its market segment is power generation, in which it offers (considerably) lower-cost solutions than gas.
- There are significant national interests surrounding the coal industry (industrial interests, employment, etc.). Thus coal has a strong political base in countries where it is produced and supports the economy by being cheap and abundant (e.g. in countries like China, the US, Poland, Russia, South Africa and Germany).

Of course, coal does not score well at all in environmental performance, but effective positioning and advocacy suggests that coal may eventually be able to offer environmentally acceptable improvements and solutions, which seems to allay any possible concerns of policymakers.

…IN WHICH "CLEAN COAL" PROMISES A BETTER FUTURE…

"Clean coal" has become a household expression, loosely used by governments and other stakeholders. The term covers any technology which reduces emissions of SO_x, NO_x, mercury, particulates and other pollutants arising from the use of coal, including carbon capture and storage technologies.[51]

…HELPED BY A WIDESPREAD MISCONCEPTION THAT CCS IS THE EXCLUSIVE DOMAIN OF COAL…

In connection with CCS, clean coal is portrayed to be environmentally friendlier than gas as a fuel for power generation and suggestively leaves out the possibility of gas with CCS in performance schedules. This consideration is backed up by the fact that today the three FID CCS projects in the

[49] Robert Bryce, 'Not Beyond Coal', CEPE , 2014.
[50] The US forms the main exception, due to its current low prices.
[51] From IEA Clean Coal Centre website.

power sector in the world use coal as feedstock. Of the nine other CCS projects in the power sector that are under consideration today, only two will use gas as feedstock and the others will use coal.[52] CCS is primarily associated with coal, and the fact that CCS with gas is cheaper and more environmentally effective is not well known.

...BY INSTITUTIONALISED PLATFORMS...

Established by the IEA, the Coal Industry Advisory Board (CIAB) is a group of high-level executives from coal-related industrial enterprises which provides advice to the IEA on a wide range of issues relating to coal.

The IEA Clean Coal Centre is governed by representatives of member countries, the European Commission, and industrial sponsors who decide the programme of work, which includes major studies of importance for all countries that produce or consume coal. It is a major provider of information, analysis and research on all aspects of coal.

…AND BY PROFESSIONAL RESEARCH AND INFORMATION ORGANISATIONS.

Located in London, the Centre employs approximately 20 professional staff, who gather, analyse and distribute information and knowledge.[53]

In addition, the World Coal Association (WCA) in London, with a strategic research centre in Beijing, presents the case for coal to key decision-makers, including ministers, development banks, NGOs, international media, the energy industry, business and finance and research bodies. Both organisations have websites for public use, including extensive databases, search engines and references to other sites.

In sum, coal performs better in all non-environmental areas, and the case for “clean coal” is strongly defended and tends to overshadow the current emissions performance of coal-fired power stations.

THEME PAPER CONSIDERATIONS AND RECOMMENDATIONS

Strong arguments can be put forward to promote the role of gas in a long-term strategy towards decarbonisation. However, these do not seem to have rooted in policies to limit global warming. Unlike renewable energy sources, gas has not been given tailor-made support within policies to contain global warming. One key expectation was that the use of gas would be indirectly promoted by the technology-neutral instruments encouraging emissions reduction (carbon pricing or standards), but at this stage their implementation remains limited and their design is insufficiently robust to effectively reduce CO_2 by limiting coal-fired generation. In certain cases, the role of gas builds up from local initiatives towards wider environmental benefits, relating to air quality in particular, and this aspect could gain greater attention in the future, as it fits well with the new bottom-up perspective for climate policies.

The absence of natural gas as an integral part of decarbonisation policies may be explained by a lack of awareness of the significant environmental benefits gas has relative to coal. Concerns of

[52] Global CCS Institute, 'Global Status of CCS 2014'.
[53] Largely made up of engineers, scientists and information specialists, according to the IEA Clean Coal Centre website.

policymakers and other stakeholders about the environmental impact of gas may be greater than the acceptance of the role that gas could play in reducing emissions. In addition to this open question on whether gas is actually green, the reliability and affordability of gas is also challenged. Although it is not always fact-based, such questioning negatively influences the perception of gas by public opinion and policymakers.

Projections of future demand for gas show growth in nearly all regions except Europe. It is most likely that the abovementioned concerns contribute directly to the sentiments of policymakers in Europe. However, the role of gas as a "partner" in decarbonisation is not widely accepted in other regions, either. In the years to come, possibly starting at COP 21, the world is likely to take on further commitments towards reducing CO_2 emissions. As long as climate action requires a supporting role for fossil fuels, the gas industry should ensure that it achieves full appreciation of the contribution which gas could make to a decarbonised energy future and, particularly, that it removes any perceived stains on the premium environmental image of gas.

To achieve such recognition, the IGU may consider placing strategic focus on the environmental record of gas, by ensuring better information sharing on the actual performance of gas and also by pursuing concrete improvements in this area, which would in turn become valuable input to the debate. From this perspective, reducing the carbon footprint of gas should be made a priority, for instance by setting targets to reduce flaring and methane emissions, sharing best practices on the matter and providing information on the scope of this issue today and on progress made. In addition, the IGU may consider clarifying the debate on the conditions for gas production. This could be done by reinforcing the dialogue on the environmental impact of shale gas extraction and also by creating a wider echo to the recent developments in biogas production. While setting new partnerships with international organisations may help in reaching a better appreciation of the added value of gas in combination with renewable sources, it is equally important to work on the role of gas in the long-term vision of a zero-carbon energy system. In this regard, the IGU can commit to the promotion of CCS projects for gas-fired power plants and fuel the debate with information on the gains in terms of emissions and on the cost-effectiveness of such technologies when applied to gas. Finally, these actions which aim at a better appreciation of the "green" properties of gas must be complemented with vocal support for strengthening the technology-neutral instruments that deliver emissions abatements (carbon pricing and emissions standards), as they remain the most efficient way to promote the real (environmental) value of gas in decarbonisation strategies.

The International Gas Union (IGU) was founded in 1931 and is a worldwide non-profit organisation promoting the political, technical and economic progress of the gas industry with the mission to advocate for gas as an integral part of a sustainable global energy system. The IGU has more than 142 members worldwide and represents more than 97% of the world's gas market. The members are national associations and corporations of the gas industry. The working organisation of IGU covers the complete value chain of the gas industry from upstream to downstream. For more information please visit **www.igu.org**

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