

Sustainable Development With Natural Gas: An Analysis

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Abstract: The role of natural gas in enriching and improving the quality of life on earth has assumed central and critical importance. All sustainable “development goals enunciated by the UNO to create an enduring equitable and progressive global economic order can be achieved if there is more and more shifting from others sources of energy to natural gas as a source of energy. Natural gas is a reliable, affordable, safe, clean and environment friendly source of energy. Our multiple problems related to gender equality, poor quality of education, social tension, health hazards unleashing of fatal diseases, economic disparity, catastrophic results in the wake of climate change, scarcity of potable water, toxicity of air to breathe, all these and many more issues can be satisfactorily resolved if significant transition from other sources of energy to natural gas as a resource of energy takes place. It is heartening that this kind of transition has already happened on a massive scale. The importance of the natural gas as a source of energy is being increasingly realized the world over. That is why the misuse of natural gas is considered a panacea to translate all SDOs into reality which will help mitigate all our socio-economic disorders” and tensions.

Key words: Natural Gas, Sustainable Development, Energy, Source, Health, Economic

1. Introduction: Natural gas has become an energy of economic growth and it plays an important role in “facilitating the achievement of all sustainable development goals. In some parts of the world, natural gas has outstripped coal as a source of energy. But its overuse has elicited its criticism with the words that it marks the beginning of the end of the hydrocarbons ‘era’. Though such allegations as the beginning of the end’ are not tenable, natural gas needs to be protected by carrying out analysis, using scientific methods. It is a very crucial scientific challenge to establish scientifically the benefits of natural gas in achieving SDGs. Its usefulness will be discussed for each of 17 SDGs. Apart from it, its benefits in terms of sustainable development states indicators in view of their acceptability fairness and allow ability for modern civilization will also be covered. Natural gas is not only environmental friendly, but also makes a significant contribution to achieving SDGs. This research intends to analyze the role of natural Gas in ensuring sustainable development in economic, environmental” and social fields.

2. Objectives:

1. To perform a systematic analysis of achieving sustainable development in the light of economic, environmental and social factors by deploying “different sources of energy.”
2. To examine the role played by natural gas in achieving various SDGs individually.
3. To compare the states of sustainable development indicators if natural gas is used in all economic sector.

3. Issues: In 2015, the UN general “assembly passed the resolution on transforming our world: The 2030 agenda for sustainable development. [1] All 17 SDGs raise demand for energy. It is vexed issue to decide which energy sources are the most effective for achieving SDGs.[2]. Figure 1 depicts the SDGs briefly, but they clearly cover the wide gamut of human relationships, their economic and social life, and giving conditions” vis-a-vis environment.

Many works have come up dealing “with the role of natural gas as a basis of sustainable energy power development[3-7]. From 1981 to 2015, the energy power production in the world had doubled – from 6.68 to 13.23 billion tons of oil equivalent, and these had been steady growth in the generation of all types of energy power had been observed. During the same period, the Earth population had grown from 4.5 to 7 billion people slightly” more than 1.5 times. Thus, “we can say that over the past 35 years the growth rate of energy generation has exceeded 1.3 times the growth rate of the world population, and this trend will apparently continue in the medium term. This is an inevitable consequence of the present stage of scientific and technological progress and the resulting accelerated growth in energy consumption in 2015 [8]. This is primarily because natural gas is the most energetically efficient and environmentally clean fossil” fuel.

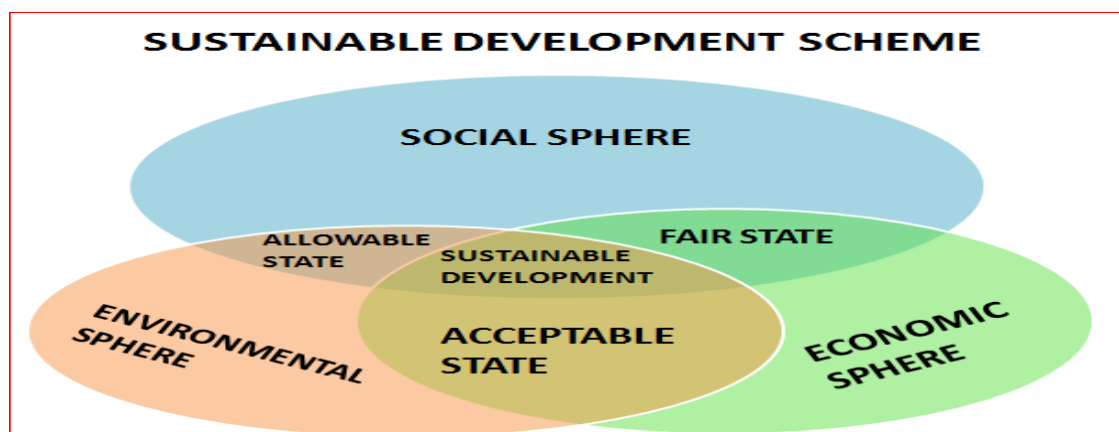


Fig. 1: Sustainable Development Scheme

The conducted “analysis of the dynamics of the energy generation structure in the world over the past 35 years has shown that the proportion of natural gas extraction has grown at the fastest rate among all types of generated” energy and was 4.5 % [9].

An “Atlas was published about the interconnection between natural gas and SDGs, i.e. the set of all relationships of natural gas and SDGs. The Atlas is a joint project of the United Nations Development Programme (UNDP), the International Finance Corporation of the World Bank Group (IFC) and IPIECA, global oil and gas industry association for environmental and social issues. The Atlas discusses the links between the oil and gas industry and SDGs. It contributes to an understanding of how the oil and gas industry can most effectively support SDGs achievement. It displays the existing contributions of the industry and encourages companies to identify additional opportunities to assist countries in SDGs achievement. The Atlas may also help oil and gas companies and their stakeholders to develop a common understanding of how the industry manages environmental and social issues while maximizing economic benefits. How do companies integrate SDGs in their core business? The SDGs range provides that business is to go beyond social investment and corporate philanthropy for long-term sustainability. Thus, discussion of each goal in this Atlas comprises ways and possibilities of integrating contributions to SDGs in the core business of a company. Many of the problems the SDGs implementation faces go beyond the capability or control of a separate company and are beyond” its core business needs.

When “developing the Atlas, its authors have found that the oil and gas industry can contribute to all 17 SDGs. However, there are some SDGs, in which the industry has particularly strong opportunities for participation, for example, goals related to affordable and reliable energy (SDG 7); climate and life below water and on land (SDGs 13, 14 and 15); economic development and innovation (SDGs 8 and 9); and health and access to clean water (SDGs 3 and 6). Many goals are interrelated. A good example is the climate change sector. Although it is included as a separate SDG, it has implications for all 17 SDGs. Climate change may disproportionately affect the poorest and most vulnerable population segment, undermining the efforts to eradicate poverty (SDG 1), achieve gender equality (SDG 5), and reduce disparities among and within countries (SDG 10). Climate change may threaten food security (SDG 2), increase the load on water resources (SDG 6), and change ecosystems and harm biodiversity (SDG 14 and SDG 15). It can also change the structure of infectious diseases’ spreading and thus affect global human health (SDG 3). All these effects could threaten the world and our safety (SDG 16). At the same time, the response to climate change may also contribute to progress in respect of other SDGs, for example by improving the energy efficiency and renewable energy and technologies’ investments (SDG 7) that can open new economic opportunities” (SDG 8) [10].

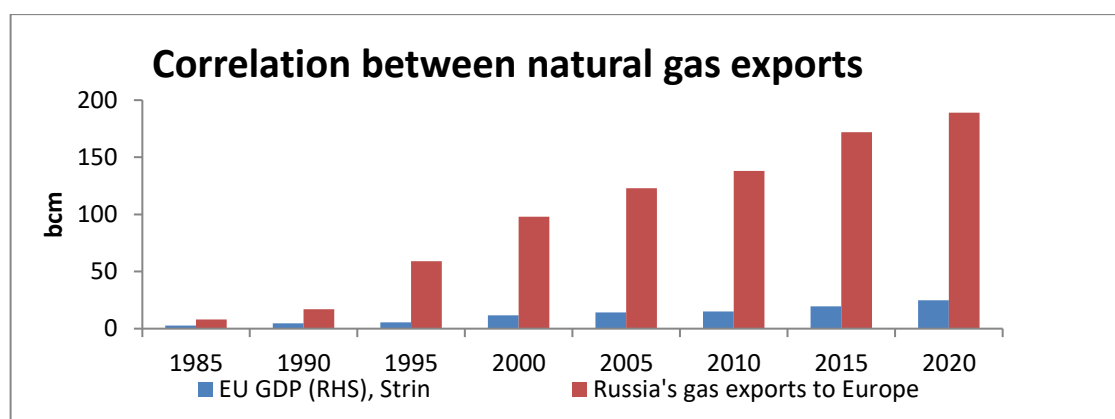
The “work by International Gas Union and Eurogas (2015) also represents a detailed analysis of SDGs. It has been shown that SDGs provide a guiding framework for society as they try to respond to a number of urgent challenges. One of these problems is the absence of access to energy; thus, SDGs have become paramount for policy-making in the field of energy power”. “However, while governments around the world have already declared that the SDGs” are “integrated and indivisible,” there are “still gaps in knowledge about how the interaction between the targets of energy power SDG and other SDGs, not related to the energy sector, may develop in different contexts. This review reports a widespread evaluation of relevant literature on energy issues (International Gas Union and Eurogas, 2015). Energy is addressed primarily to achieve SDG 7, ensuring access to affordable, reliable, sustainable and modern energy for all people. Particular attention in publications is paid to the role of natural gas” for sustainable development [11].

All researchers [12-15] note the “positive role of natural gas in SDGs implementation. Most experts agree that the ability to provide economically efficient development of extensive globally scattered deposits of natural gas is the basis for the energy industry of the future. This resource base is a new opportunity for domestic and global economic growth, as well as for change in fuel choices in many sectors. In recent decades, an unprecedented breakthrough in the gas industry has been achieved, which helps to improve the energy balance and promote low-carbon economy development [16]. The ways the gas sector may contribute to SDGs implementation are described in works [17-21]. And even gender equality is related

to natural gas (Cutter et al., 2015). It is emphasized that natural gas has been rapidly gaining geopolitical importance (Rice University's Baker Institute for Public Policy, 2004). Gas is transported over long distances for consumption in various sectors of the economy. The growing importance of natural gas imports for the modern economy will promote new ways of thinking about energy supply security. The relationships developing between major gas suppliers and major consuming countries will create new geopolitical initiatives, which will reach the highest levels of economic and security policy. The work by Sinclair (2018) explicitly states the transition" from coal and oil to natural gas.

4. "Methodology, Results and Discussion: The" economy "plays a major role in people's lives, and it is well known how energy resources affect it. Economic growth is associated with the increasing use of natural gas. Natural gas is one of the cheapest resources. In the equivalent amount of energy (per 1 MW), natural gas capital intensity is \$ 1,023, whereas, for example, solar power capital intensity is \$ 3,873 [22]. The exports of natural gas to Europe are well correlated with the growth of the EU economy" (Figure 2).

The use of natural gas "requires the minimal involvement of land resources (Figure 3). This is despite the fact that each year we lose 6 million hectares of arable land that is the basis for the production of food resources. Our daily lives depend on reliable and affordable energy services, as well as on uninterrupted operation and equitable access to energy resources. One in five people worldwide has no access to electricity. 2.8 billion people use wood, charcoal, dung, and coal for cooking and domestic heating, which annually causes more than 4 million deaths due to indoor air" pollution.



"Fig. 2. Correlation between natural gas exports to Europe and the EU economic growth"

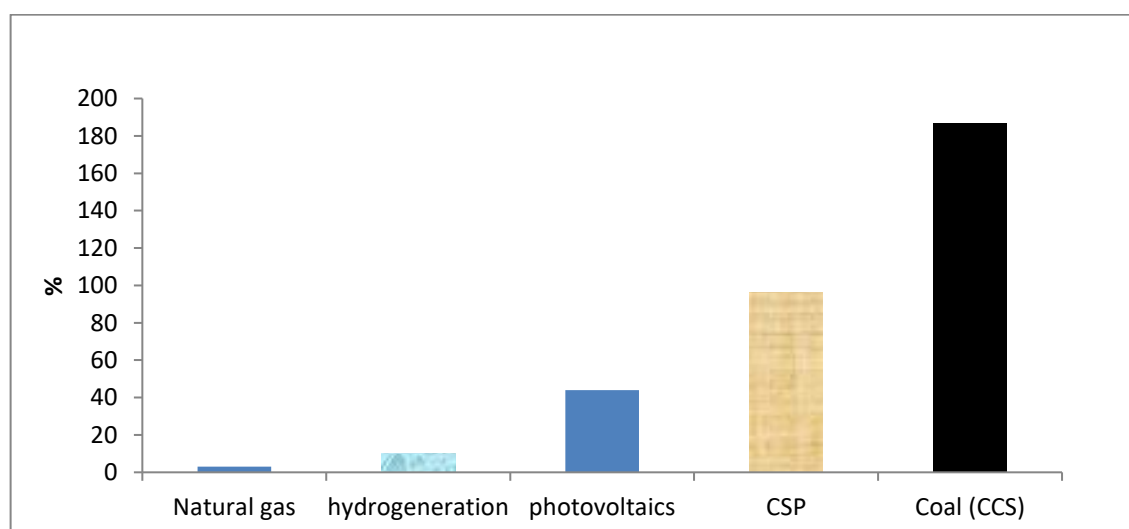


Fig. 3. "Contribution of various sources of electric power to the land use (UN Environment Programme, 2018). CSP – concentrated solar power"

The solution to "these problems is to use natural gas since it gives a reliable and uninterrupted supply of energy (energy security). Remaining technically recoverable resources of traditional gas are enough for 300 years (with the current level of gas extraction). Pipeline natural gas ensures sustainable gas supplies in the long term. Natural gas is the most promising energy source. Natural gas consumption is expected to increase in all sectors, and the consumption of coal and oil is expected to decrease (Figure 4). And finally, the energy return on investment for different energy sources, i.e., the ratio of usable (useful) energy produced from a particular energy source to the amount of energy expended to obtain that energy

resource, is in favour of natural gas (Figure 5) (U.S. National Renewable Energy Laboratory, 2018). Natural gas is an important energy source to reduce pollution; it contributes to the maintenance of normal environmental conditions. Compared with other energy sources, natural gas has a number of advantages:

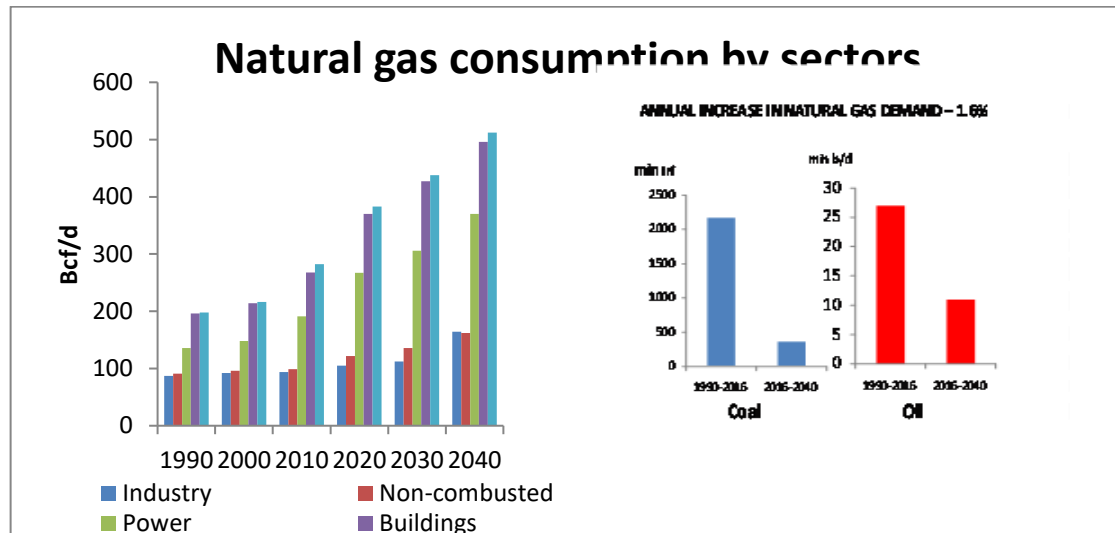


Fig. 4. "Natural gas – growth prospects (BP, 2017a)"

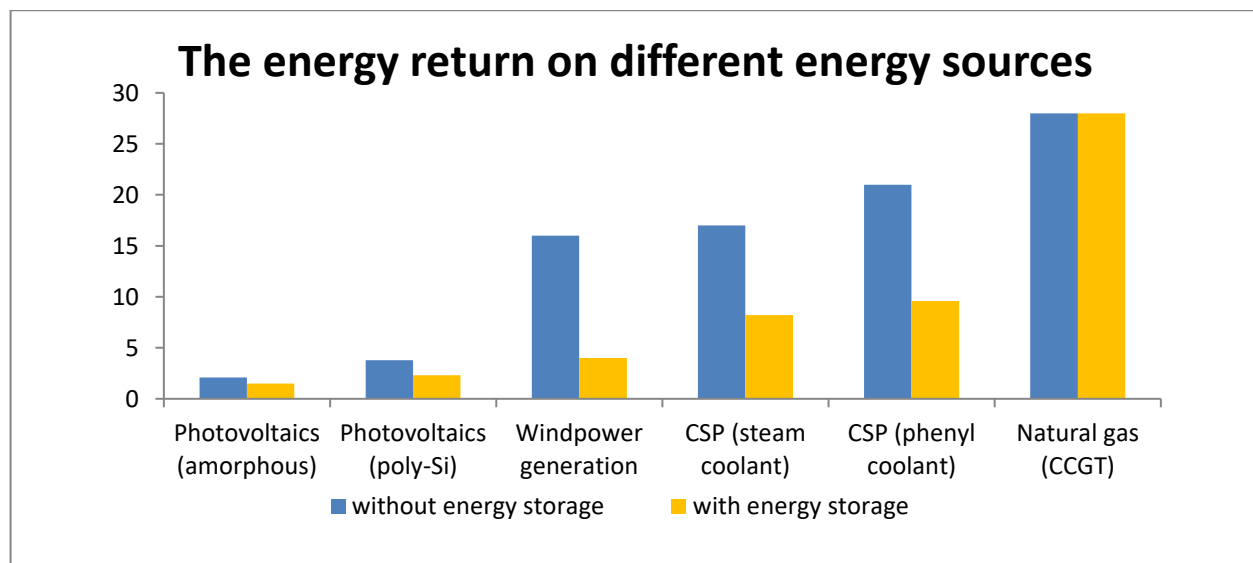


Fig. 5. The energy return on different energy sources"

"In burning it releases mainly carbon dioxide and water vapors a mixture we encounter in our glasses of soda water;"

- "It starts burning at once, and its combustion process is easily adjusted"
- "It contains no solid contaminants and other harmful components; and it is relatively cheap."

Methane is one of the "greenhouse gases, it has been criticized by fighters against global warming, however, it is known that methane is found in the atmosphere primarily in the surface layer, which is called the troposphere, and it has a thickness of 11-15 km. Methane concentration does not depend a lot on the height from the ground surface to tropopause, which is caused by the high speed of mixing throughout the height in the range of 0-12 km (1 month) compared with methane lifetime in the" atmosphere.

The "study of the isotopic composition of gases testifies that the role of fossil methane as a greenhouse gas has" been "exaggerated. The study by Nisbet et al. (2016) of the ratio of methane isotopes in two stable carbon isotopes ^{12}C and ^{13}C has shown that methane emissions from gas fields are typically more enriched with ^{13}C compared to the atmosphere, and they are not the cause of the observed isotope shifts. Emissions from quarry bituminous mines of coal basins in the Southern Hemisphere have possibly contributed to the isotope shifts. A large part of the world emissions' variability may be due to the El Niño-Southern Oscillation (ENSO) indicators. It was found out that a globally averaged molar proportion of methane in the atmosphere had risen from 2007 to 2013 by 5.7 ± 1.2 parts/bln/year. At the same time, the indicator $\delta^{13}\text{CCH}_4$ (the ratio of carbon isotopes $^{13}\text{C}/^{12}\text{C}$ in methane) since 2007 has shifted towards significantly more negative

values. The extreme growth of value by $12.5 \pm 0.4 \text{ bln}^{-1}$ was recorded in 2014, a further shift to more negative values was observed in most latitudes. Isotope evidence represented in work by Nisbet et al. (2016) indicates that the growth of methane is mostly influenced by an increase in biogenic methane emissions, particularly in the tropics, for example, due the expansion of tropical wetland areas in the years with abnormally high rainfall or due to the increase in the number of sources of methane emissions related to agriculture sector, such as ruminants and rice" fields.

According "to Aksyutin et al. (2018), the" "share "of methane in total greenhouse gas emissions is low, and the share of methane emissions from the Russian gas industry is only 0.004% of global greenhouse gas emissions. The total content of methane in the atmosphere is about 5 billion tons while the annual emissions, estimated at 540-568 million tons, are almost equal to the natural intake from the atmosphere (529-555 million tons). That means the mechanism of changes in methane concentration in the atmosphere has its own natural character similar to the regulation of water vapors balance."

The "5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) notes":

- There is no "single system of indicators for accurate comparison of all the effects of various Emissions, all the metrics have limitations and uncertainties"
- Up to the IPCC 4th "Assessment Report, the global warming potential (GWP) was the most common metric indicator"
- Nowadays the role of "global temperature change potential increases (GTP), based on the change in global average surface temperature at the selected time and also in respect of the change caused by the CO₂ reference gas. According to the specified methods (potentials) methane has different conversion factors to convert in CO₂-equivalent. The IPCC has conducted potentials data refinement in preparing the regular assessment reports. Figure 6 shows the evolution of methane potentials compared to CO₂ according to different methods in the IPCC reports".

According to "experts, the anthropogenic influence on climate as a whole is much lower than that of natural causes (deviation of Earth's orbit, change of solar activity, volcanic phenomena with aerosols release), and is compensated by natural recovery processes and self-regulation (natural balance) in the atmosphere."

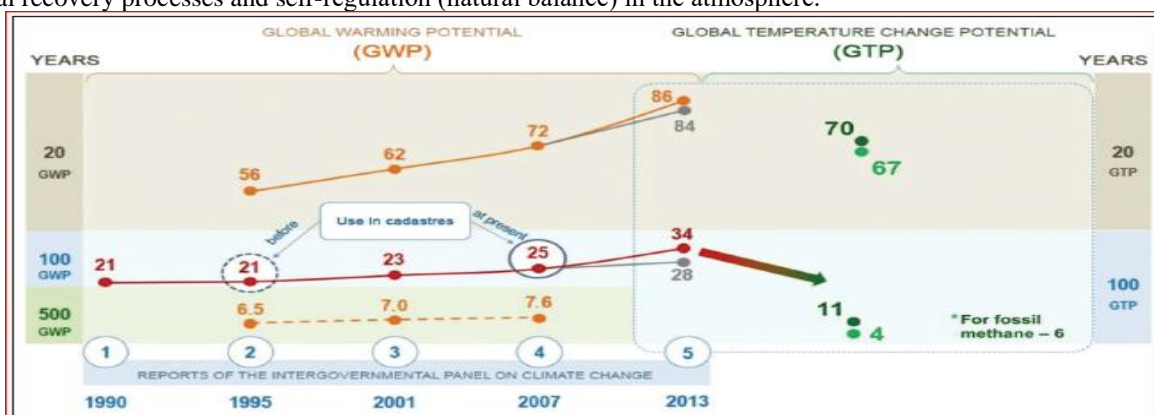
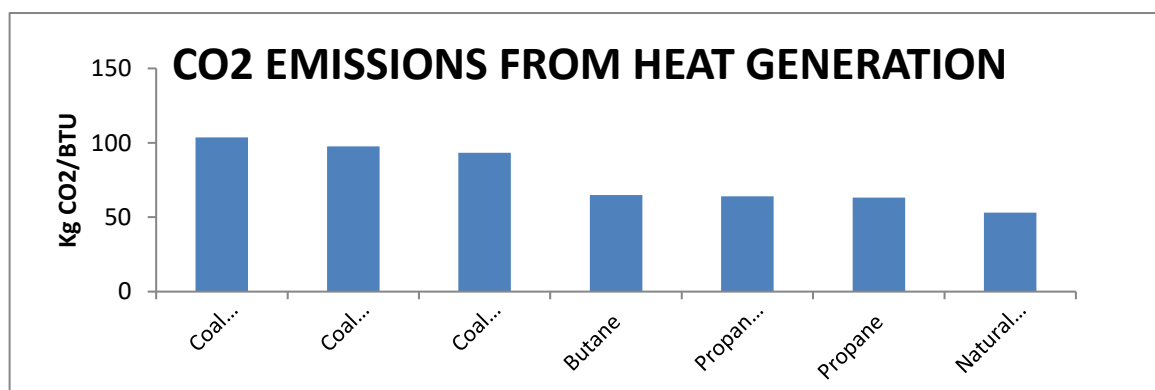


Fig. 6. CH₄/CO₂ "estimated ratio comparison according to different methods of assessing methane's role in climate change"



"Fig. 7. Climate safety of natural gas"

In the assessment of "methane's contribution to global climate change, it has to be taken into account that its percentage in the overall picture of the greenhouse gases' impact on climate is 4-9%, whereas water vapor's – 36-72%. It is water vapors that supports thermal balance and is a natural regulator of atmospheric processes. Analysis of the role of each greenhouse gas confirms the conclusion that the methane's impact on climate can be regarded as insignificant in the context of water vapors natural regulation and methane's short life in the atmosphere. For an objective assessment of different types of fuel, it is required to analyze the CO₂ emissions when using them, as well as the carbon footprint (greenhouse gas emissions throughout the production chain) of energy resources. CO₂ emissions vary for different types

of fuel. Figure 7 gives their comparison according to data [23-25].” It “is obvious that heat generation from natural gas is accompanied by lower CO₂ emissions, and that electricity generation” from gas “is characterized by the lowest carbon footprint.” Generation “from gas is characterized by the minimal impact on the ecosystems. The second objective of the work is the analysis of gas’ contribution to each SDG (Table 1) to objectively compare natural gas to other energy sources. Social aspects of sustainable development are evident in the objective view of the use of natural gas. It is above all the impact on human health (SDG 3). Figure 8 presents emissions from various energy sources, affecting human” health [26]. The “coal causes 36% of lung cancer deaths, 34% of deaths from stroke, and 27% of deaths from heart diseases. In today’s world, the total area of cities constitutes only 3% of the Earth’s land, but they account for 60-80% of energy consumption and 75% of carbon dioxide” emissions. “Carbon footprint” of gas engine transport” (CNG) is “lower in comparison with the transport running on oil fuels. In comparison with electric cars, CNG has advantages with a significant percentage of coal in the energy mix.”

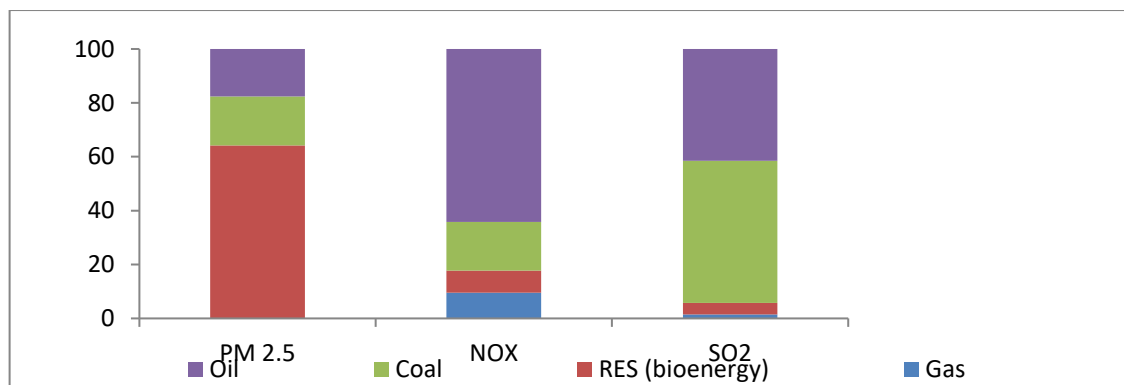
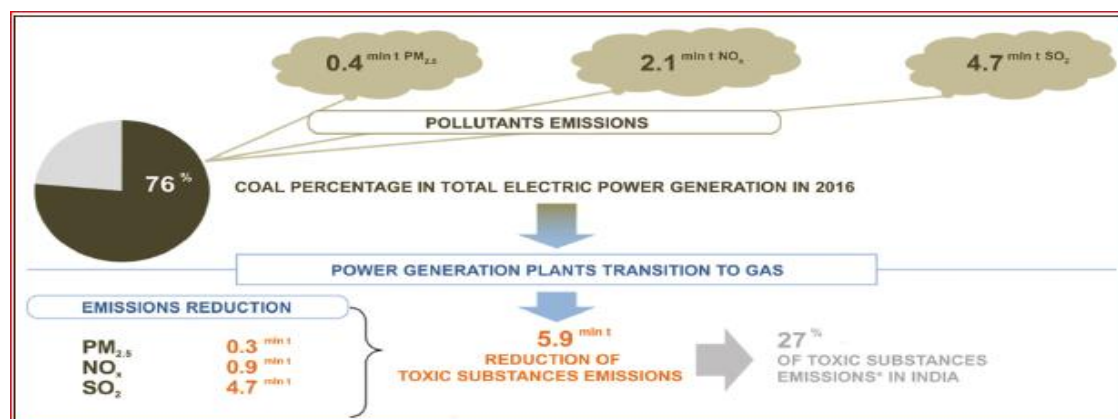


Fig. 8. Contribution of “various energy sources to global emissions of toxic substances, 2015. PM_{2.5} – solid particles (particulate matter) smaller than 2.5 microns”

Gas “infrastructure development greatly contributes to air cleanliness. This issue is particularly pressing in China and India. To achieve the SDG 3 (good health and well-being), coal power plants should be closed and electric generation with the use of natural gas should be developed. Figure 9 provides data in terms of the sources on the example” of India [27]. Smog in “cities is a very serious social problem. Today, 50 % of the world population, i.e. 3.5 billion people, lives in the cities. In 2014, 9 out of 10 people who lived in cities breathed the air that did not meet the safety standards set by the” WHO. “Toxic footprint in gasoline production is 7 times higher than for the CNG lifecycle.”

The “third objective, which is the analysis of sustainable development’s components”ratio “economy-ecology-social field,” should “be associated with the global challenges of today. Now it is trendy to start a list of global issues”with “global warming.” It“should be noted that the scientific community is already shifting away from the terminology of global” warming: The term “climate change” is more common” now.



“Fig. 9. Polluting emissions potential reduction during the transition from coal-fired electricity generation to gas-fired electricity generation. PM_{2.5} solid particles (particulate matter) smaller than 2.5 microns”

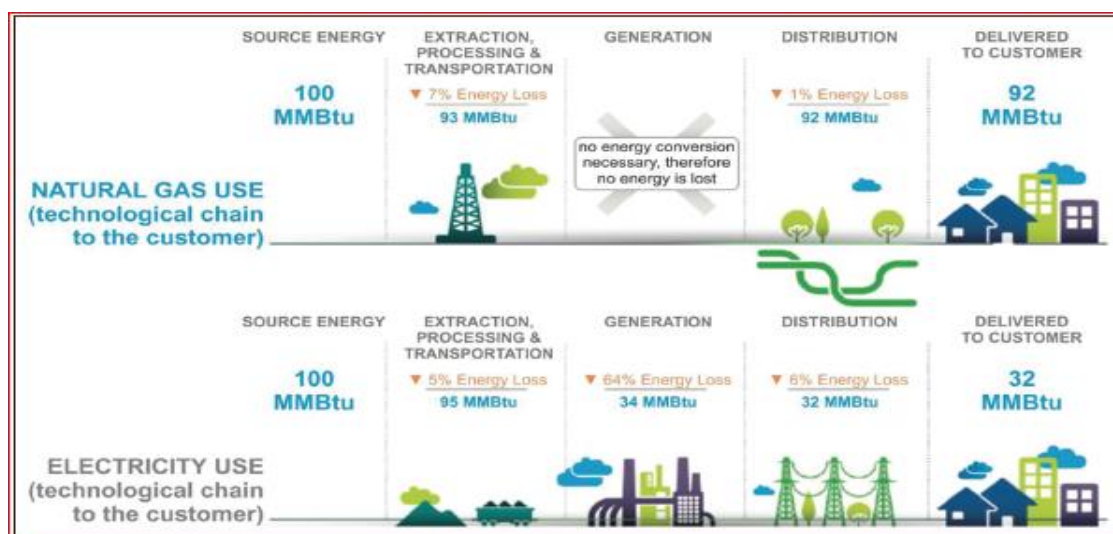


Fig. 10. "Responsible energy production and consumption (American Gas Association, 2018)"

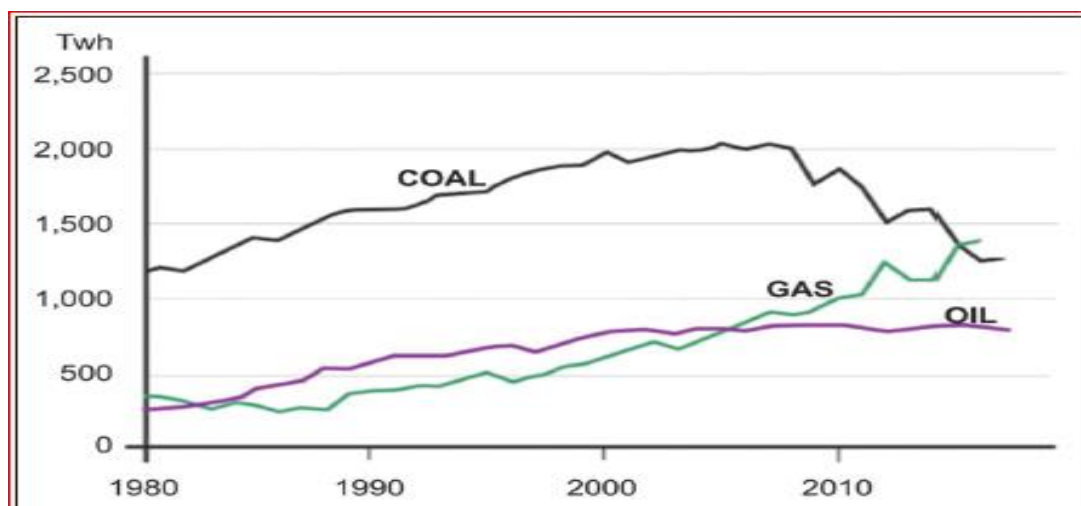


Fig. 11. "Victorious march of natural gas in the USA (Carbon Brief, 2017)."

There are "other global problems as well – the depletion of resources (earth, soil, water, forest, biological, etc.), as well as global pollution (garbage islands). For the sustainable development indicators ratio to be acceptable, allowable and fair, we should ensure the solution of other challenges along with the climatic ones. Water resources are a crucial issue (SDG 6). Water shortage affects more than 40% of the world population. 783 million people do not have access to clean water. More than 80% of the liquid wastes obtained as a result of human activity are dumped into rivers or seas without any processing. Freshwater, a finite natural resources, constitutes only 3% of all the world's water reserves." Natural "gas ensures responsible energy consumption (SDG 12). Figure 10 shows data on production chains. The use of natural gas is characterized by a minimal loss of energy" Depletion "of material resources is also an important issue. It is a matter of concern that in pursuance of the improvement of solar energy" efficiency:

1. Valuable and "rare materials (rare-earth) are used: Energy is renewable but materials are not".
2. New "materials are produced and used, many of which contain toxic substances: Solar panels are a source of waste 300 times more toxic than waste from conventional energy generation" (countries like Ghana, India, and China, where many people live at the expense of electronic wastes, will suffer from "solar garbage" much "more than the countries that use these solar panels). Generation from gas is characterized by the lowest material and valuable chemical elements' consumption."

At the "conclusion of the analysis, we should also mention gas hydrates, their reserves being enormous. According to the United States Department of Energy, the amount of gas in Arctic sands amounts to 283 billion m³. Hydrates from marine sandstones contain from 1000 to 10,000 trillion ft³, and hydrates scattered in marine mud contain hundreds of thousands of trillion ft³ of methane (U.S. Department of Energy, 2018). One of the technical solutions with synergistic effect may be the use of a floating NPP for the methane hydrates" extraction

Victorious "march of natural gas continues. It has left behind coal and has a rate higher than that of oil (Figure 11). methane (U.S. Department of Energy, 2018). One of the technical solutions with synergistic effect may be the use of a

floating NPP for the methane hydrates' extraction Victorious march of natural gas continues. It has left behind coal and has a rate higher than that of oil (Figure 11)."

5. Conclusions: Natural gas is playing an indispensably important role in realizing the SDGs adopted by the U.N. journal "assembly in 2015. The use of natural gas can play a crucial role in eradicating poverty, hunger and in ensuring healthy and long life. Pollution free environment is necessary for preserving health and natural gas helps keep environment clean and unpolluted. The use of natural gas makes the economy of a country sustainably sound and robust and also contributes to making people healthy. All this help contribute to the growth of education both in quantitative and qualitative terms. With the robust economic order in place, even gender equality issues can be satisfactorily resolved. The "most important SDGs 6 and 7 concerning water and access to energy resources could be properly addressed through the use of natural gas. 20% people of the world are deprived of the facility of electricity. 2.8 billion People have to depend upon pollution generating fuel comprising wood, charcoal, dung and coal for cooking and heating purposes. This polluted fuel causes as many as 4 billion deaths. It polluting fuel is replaced by natural gas; all such deaths can be prevented. There is no denying the fact that natural gas is a reliable, affordable and uninterrupted source of energy supply, thus ensuring energy security. Natural gas energy being affordable and convenient source helps reduce disparity within and among countries (SDGs 9 and 10). 50% population of the world (3.5 billion people) lives in cities. 90% of them inhale air which is too toxic, polluted and is not safe as per the safety standards laid down by the WHO. Transport emissions make the air so polluted that breathing in such air amounts to catching fatal diseases carbon emissions in petrol are 7 times more than CNG. Carbon footprint' of gas engine transport is much less than transport running on oil motor fuels. As the demand for water, food and energy is likely to escalate by 2030, to be specific, it is likely to spike by 40%, 50% and 40% water, food and energy respectively, prudent production and consumption are imperatively necessary. The use of natural gas undergoes minimum loss of energy" (SDG 12). "Generation of electricity from gas is much more efficient than from renewable sources of energy, since the former has lowest material and valuable chemical elements' consumption. Natural gas is very useful in combating the menace of climate change (SDG 13). Heat production from natural gas causes much lower CO₂ emissions and leaves the minimum trail of "carbon footprint" Marine and coastal biodiversity provides sustenance to 3 billion people. Eutrophication of coastal water is likely to damage 16% of ecosystem generation from gas causes minimal impact on ecosystem (SDGs 14 and 15). It natural gas is easily available as source of energy, it will help ease tension and promote peace and amiability in the society (SDGs 16) Natural gas and global partnership are intimately related (SDGs 17). A good example pertaining to it is the nard stream gas transmission system. All the detailed discussion unfolded above makes it abundantly clear that natural gas is way above other sources" of energy." The increasing use of natural gas will help implement all the SDOs, specified by the UNO successfully. With the "sustainable development of the Global economic order, income and quality of life on the earth will register remarkable improvement. The importance of the role of Natural Gas in achieving sustainable development goals just can't be overemphasized."

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