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The development of natural gas in Asia—the results of the forecast scenarios of the POLES model

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ABSTRACT

Many studies have shown the important role of natural gas in worldwide energy transition to gradually reduce the impacts on climate change. Asia is considered the centre of future gas demand growth. With a view to demonstrating the role of natural gas in the energy transition in Asia, this article will analyse the results from the scenarios forecasting the development of natural gas based on the Prospective Outlook on Long-term Energy Systems energy forecasting model.

1. THE ROLE OF NATURAL GAS IN THE GLOBAL ENERGY OUTLOOK

An unceasing increase in energy demand is associated with economic growth, as energy is a fundamental and essential input for economic activities. This has caused some countries to face the risk of energy shortage and exhaustion. In addition, the rise in energy demand is the leading cause of environmental pollution, air pollution, global climate change and global warming from which humanity is suffering. As a result, policies on climate and the environment have been tightened over the years. In the current context, in case it is impossible to switch immediately from traditional energy sources to renewable ones, natural gas is considered an essential bridge in the energy transition in the world. Especially after the 2015 Paris Climate Change Conference (COP 21), all countries around the world engaged in a sustained effort to minimize climate change, renewable energy and low carbon energy such as natural gas will certainly be prioritized in uses to replace gradually away from traditional fossil energy resources that emit more CO_2 such as coal and oil. While the conditions for the development of renewable energy sources still remain difficult in terms of technology and costs—particularly in developing and emerging countries—the role of natural gas could be very important in the energy transition process in the short and medium term. Although natural gas has its own environmental challenges, it remains a relatively clean fuel, both from a local environmental and carbon footprint perspective. Therefore, it is an appropriate fuel in the energy transition.[1] We can therefore expect a significant transfer from traditional sources to natural gas.

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1 IEA, *Gas Medium Term Market Report 2016* (IEA 2016).

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Many research reports of various organizations (eg International Energy Agency, World Energy Council, University of Energy Research Institute Oxford—UK, Massachusetts Institute of Technology—USA), energy corporations (BP, Shell, Exxon-Mobil) and researchers around the world related to the development of natural gas, the forecast of natural gas potential, gas market, gas price have been published in recent years. These studies have shown massive growth in the worldwide natural gas market, in general, and especially the liquefied natural gas (LNG) market, in particular in Asia.[2] According to the International Energy Agency (IEA), the world is entering a golden age of natural gas.[3] Studies also show that the substantial increase of natural gas supplies in the world, especially unconventional gas in the future, will strongly affect the rise in demand for natural gas in the future. However, this growth will depend significantly on policies to exploit and use unconventional gas resources globally and the changes in natural gas market policies in regions. Annual reports of organizations and companies on energy prospects in the world also mention the growth of natural gas, as well as the robust growth of the LNG market in the future.[4]

There are many reasons to believe in a revolution that will change the gas market and increase the world's demand for natural gas, especially LNG. First of all, there is a substantial increase in natural gas supply globally, especially unconventional natural gas sources.[5] No longer considered a resource on the verge of exhaustion, gas supply has become abundant thanks to the appearance of unconventional natural gas supply.[6] For example, the recent shale gas revolution in the USA has turned this country from a major gas importer in the world to a natural gas exporter.[7] Besides, with the ever-evolving technology, the LNG market has been growing rapidly in recent years.[8] Many countries have priority policies in increasing natural gas to replace traditional energy sources such as coal and oil in their energy structure.[9] These things will rapidly change the gas market in the world and create many opportunities for regional markets and other countries to increase the use of natural gas, especially LNG in their energy structure.[10]

2 MIT, *The Future of Natural Gas* (MIT Study 2010); Silvia Colombo and others, *The Future of Natural Gas: Markets and Geopolitics* (Lenthe/European Energy Review 2016); Minh Thong Le and others, 'Can Natural Gas Play an Important Role in the Energy Transition in Asia in the Future?' (2019) 7 Eurasian Journal of Business and Management 28.

3 IEA, *World Energy Outlook - Are We Entering a Golden Age of Gas*? (IEA 2011).

4 IEA, *World Energy Outlook 2018* (IEA 2018); BP, *BP Energy Outlook - 2016 Edition* (BP 2016). *Note:* The Asia in this study includes China, India, Northeast Asia, Southeast Asia and some other countries, excluding Turkey and Russia.

5 Jane Nakano, *Prospects for Shale Gas Development in Asia: Examining Potentials and Challenges in China and India* (Center for Strategic and International Studies 2012); Christopher R Clarkson, Jerry L Jensen and Simon Chipperfield, 'Unconventional Gas Reservoir Evaluation: What Do We Have to Consider?' (2012) 8 Journal of Natural Gas Science and Engineering 9; Philip Andrews-Speed and Christopher Len, 'China Shale Gas: Can the Pace Be Sustained?' (Energy Studies Institute-NUS 2015) <http://esi.nus.edu.sg/publications/esi-publications/publication/2015/01/12/china-shale-gas-can-the-pace-be-sustained-> accessed 11 May 2015; Minh Thong Le, 'An Assessment of the Potential for the Development of the Shale Gas Industry in Countries Outside of North America' (2018) 4 Heliyon e00516.

6 IEA, *World Energy Outlook 2011_ Are We Entering a Golden Age of Gas?* (IEA 2011); Christophe McGlade, Jamie Speirs and Steve Sorrell, 'Unconventional Gas – A Review of Regional and Global Resource Estimates' (2013) 55 Energy 571; Bruno Weymuller, 'Les Perspectives Du Shale Gas Dans Le Monde' [2010] Note de l'IFRI <http://ifri.org/downloads/noteenergiebweymullerproteg.pdf> accessed 21 September 2014; Roberto F Aguilera, Julian Inchauspe and Ronald D Ripple, 'The Asia Pacific Natural Gas Market: Large Enough for All?' (2014) 65 Energy Policy 1; Minh Thong Le and others, 'What Prospects for Shale Gas in Asia? Case of Shale Gas in China' (2021) 13 The Journal of World Energy Law & Business 426.

7 James Henderson, *The Potential Impact of North American LNG Exports* (Oxford Institute for Energy Studies 2012).

8 Howard V Rogers, *Asian LNG Demand: Key Drivers and Outlook* (2016); Leslie Palti-Guzman, 'The Future of Asia's Natural Gas Market: The Need for a Regional LNG Hub' (2018) 25 Asia Policy 101.

9 Fredrich Kahrl and others, 'Strategies for Expanding Natural Gas-Fired Electricity Generation in China: Economics and Policy' (2013) 2 Energy Strategy Reviews 182; Lei Tian and others, 'Stimulating Shale Gas Development in China: A Comparison with the US Experience' (2014) 75 Energy Policy 109.

10 Henderson (n 7); Mehmet Melikoglu, 'Shale Gas: Analysis of Its Role in the Global Energy Market' (2014) 37 Renewable and Sustainable Energy Reviews 460; Minh Thong Le, 'The Role of Conventional and Unconventional Gas in the Energy Transition in Asia' (Theses, Université Grenoble Alpes 2017) <https://hal.archives-ouvertes.fr/tel-01587295> accessed 21 November 2018.

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2. SCENARIOS FOR THE DEVELOPMENT OF NATURAL GAS IN THE POLES MODEL

Introduction of the POLES model

Energy issues have a close but complex relationship with economic activities and their impacts on the environment. Therefore, in any model selected to analyse scenarios, it is necessary to show the interactions between energy policies, climate policies, market dynamics and energy prices. But there is a wide variety of models used to assess and forecast medium- to long-term prospects, energy impacts and climate change.

Among the models that can be used to evaluate the energy system and climate policies, the Prospective Outlook on Long-term Energy Systems (POLES) model offers a very detailed and complete description of national and international energy systems, with high-level details offering good readability of technological and sectoral developments and considering the dynamic adjustment mechanisms of energy supply and demand to price variations. This model also makes it possible to integrate and analyse the impacts of international climate policies.[11]

Assumptions and scenarios in the POLES model

The main exogenous variables in the POLES model

Economic activity and demographics are the main factors influencing energy demand and the changes in the energy mix in all energy scenarios. The projections in the scenarios are very sensitive to assumptions about the GDP and the population growth rate. The introduction of these exogenous assumptions makes it possible to simulate the evolution of the energy system on a global scale and for each country or region. The model database is essentially established from the information collected by the ENERDATA company for data related to the international energy system. Growth assumptions are based on the United Nations and the International Monetary Fund.

The specific assumptions in the POLES scenarios

Natural gas will play an increasingly important role in the energy mix to come. In addition, with enormous resource potential, unconventional gas can play a significant role in the future of gas in the global energy mix. In particular, shale gas production in the world plays an important role in balancing gas supply and demand in different regions and markets. According to the IEA, unconventional gas will play an important role in meeting the increase in demand and they could account for almost half of the increase in global gas production in 2035, and the share of unconventional gas production in 2040 would amount to 26 per cent of global gas production.[12] The increase in unconventional gas resources would come mainly from China, the USA and Australia. In particular, the production of unconventional gas will grow rapidly after 2020.[13] Therefore, the use of natural gas will be enhanced in many other sectors, particularly for replacing coal in the electricity sector. The scenarios that we will build with the POLES model will include factors favourable to the penetration of natural gas into the energy balance sheets.

This new reference scenario, GAS +, is a projection that describes the outlook for the global energy system in a favourable context for natural gas. In this scenario, the increase in gas consumption is clearly expressed by considering various factors which are good to gas production and consumption.

We built another scenario by considering implementing policies to reduce CO_2 emissions (scenario GAS+ 2°C). As a result (and given the lower gas emissions compared to coal), rapid growth in the demand for natural gas in the energy transition, particularly in the Asian energy market, is expected. Climate policies play an essential role in guiding energy use in each country or region. Due to serious

11 P Criqui and others, '«POLES 2.2», Commission Européenne, DG XII, EUR 17538 EN' (1996); Enerdata, *POLES Manuel - Version 6* (Enerdata 2010); Silvana MIMA, *Initiation Au Modèle POLES* (Silvana MIMA 2013).

12 IEA, *World Energy Outlook 2015* (OECD Publishing 2015) <http://www.myilibrary.com?id=876457> accessed 6 September 2016.

13 IEA, *World Energy Outlook 2012* (2012); IEA, *World Energy Outlook 2013* (2013); IEA ibid

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expected impacts, climate policies are now orienting the world energy system in the direction of deep decarbonization, in particular after COP 21. These are likely to modify energy mixes, particularly the weight of energies, carbon emissions and, therefore, influence gas demand levels. The Asian region is already the most dynamic market globally, and its development strongly influences climate change in the world. Countries in the region recognize the importance of climate-energy policies to achieve global emissions reductions successfully. Indeed, Asian countries made many ambitious commitments to reduce greenhouse gas emissions at COP 21.

3. RESULTS OF THE SCENARIOS OF THE POLES MODEL

The rapid growth of natural gas demand

Asian countries face serious problems related to the local environment and climate change, especially air pollution in cities and greenhouse gas emissions. Asian governments, especially the Chinese government, have ushered in policies to improve the environment and limit greenhouse gas emissions. One of the choices is to increase the use of gas to replace coal and oil in several sectors, especially power generation.

In general, in all scenarios, the demand from Asia will grow rapidly (Table 1). The growth rate of Asian gas demand is higher than that of any other regions in the world. If the growth in world gas demand in the GAS + scenario is 1.88 per cent per year, in the Asian region, this rate will be around 5 per cent per year in all scenarios. This growth rate is equivalent to the level of gas growth in Asia in the IEA's Golden Age of Gas scenario in 2011 (GAS 2011 scenario).

To achieve emission reduction, gas consumption in Asia in the POLES scenarios is higher than that in the IEA scenarios. Table 2 shows the evolution of gas demand in Asia and its share between the POLES and IEA scenarios. In 2030, Asia's share of gas amounts to 27 per cent of global gas demand, while its share in the POLES scenarios exceeds 37 per cent, with a maximum of 42 per cent in the GAS + 2°C scenario. In 2040, gas demand would be around 1277 Mtoe, or 28 per cent of the total global gas demand according to the IEA scenario in 2015 (IEA-WEO 2015). While in the POLES scenarios, the share of gas demand would be twice as large as in the IEA estimate (see Table 2): 43 per cent and 52 per cent of the total demand, respectively, in the GAS + and GAS + 2°C scenarios. In 2050, gas demand in Asia will occupy around 48 per cent of worldwide demand in the GAS + scenario and would reach 57 per cent in the GAS + 2°C scenario.

The important role of natural gas in the energy transition

In the GAS + scenarios, alongside the rapid increase in carbon-free energies such as nuclear, wind, solar or biomass, natural gas is seen as an essential energy source in the energy transition process, particularly in the Asian region. The intensification of gas consumption in Asia will make it possible to meet the growing demand for energy while controlling emissions. In any case, whether climate policies are weak or restrictive, the demand for gas in Asia will increase sharply. In contrast, the demand for highly emitting energies such as coal will decrease. Figure 1 shows the evolution of the energy structure and the important role of natural gas in the Asian energy mix in the GAS + scenario and the GAS + 2°C scenario.

In contrast to the GAS + scenario, in the emission-constrained scenarios, energy demand in Asia will increase more slowly due to a climate policy aiming to reduce CO_2 emissions, especially after 2020 when the value of carbon increases rapidly.

In the GAS + scenario, fossil energy consumption will continue to increase until 2040, while in the case of a very restrictive climate policy (GAS + 2°C), the trajectory of fossil energy consumption will start to decrease after 2025 (see Figure 1). While oil and especially coal tend to decline rapidly in the GAS + scenarios, natural gas consumption will continue to grow. Although gas consumption in the GAS + scenarios will be lower than that in the GAS + scenario, its share in the Asian energy mix will be very significant.

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Table 1. Gas demand growth rates in different scenarios

Scenarios	*World, %*	*Asia, %*
GAS 2011 (WEO 2011)	1.80	6.70
WEO 2015	1.40	3.60
GAS+ 2°C	1.10	4.82
GAS+	1.89	5.01

Source: IEA, *World Energy Outlook—Are We Entering a Golden Age of Gas*? (IEA 2011) and result from the POLES model.

Table 2. Natural gas demand and its share in the scenarios (Mtoe)

Scenarios	*2020*	*2030*	*2040*	*2050*
IEA-WEO 2015	774	1035	1277	–
Natural gas in the scenario, %	22	26	28	–
GAS+	833	1769	2444	2724
Natural gas in the scenario, %	23	37	43	47
GAS+ 2°C	846	1895	2446	2477
Natural gas in the scenario, %	24	42	52	57

Source: IEA, *World Energy Outlook 2015* (OECD Publishing 2015) <http://www.myilibrary.com?id=876457> accessed 6 September 2016 and result from the POLES model.

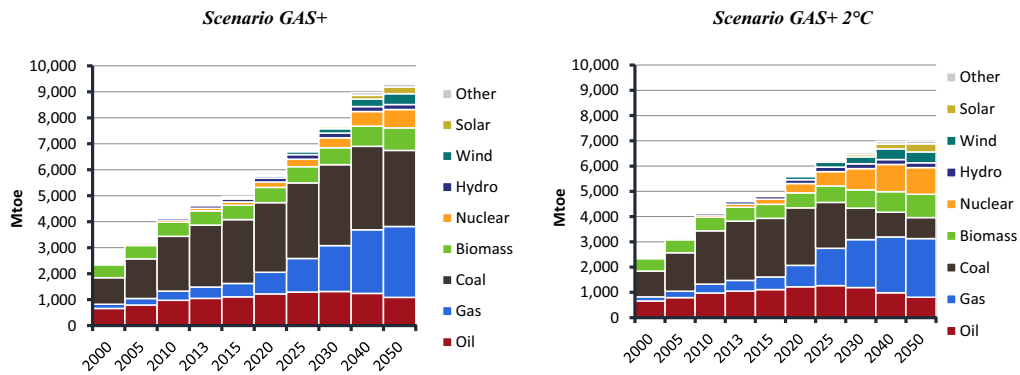

Figure 1. Asia's total primary energy supply in POLES scenarios.

(**a**) Scenario GAS+ and (**b**) Scenario GAS+ 2°C.

Source: Result from the POLES model.

Rapid reduction in emissions

Although natural gas is a fossil fuel, it can be considered a relatively clean energy source. Under current conditions, as long as we do not have a 100 per cent renewable energy system, natural gas will substitute for other more emitting fossil fuels. Along with the development of renewable energies, natural gas will play an important role in the energy transition in Asia in scenarios with emission constraints, particularly with the replacement of coal. This development will significantly improve the quality of the environment and the air by

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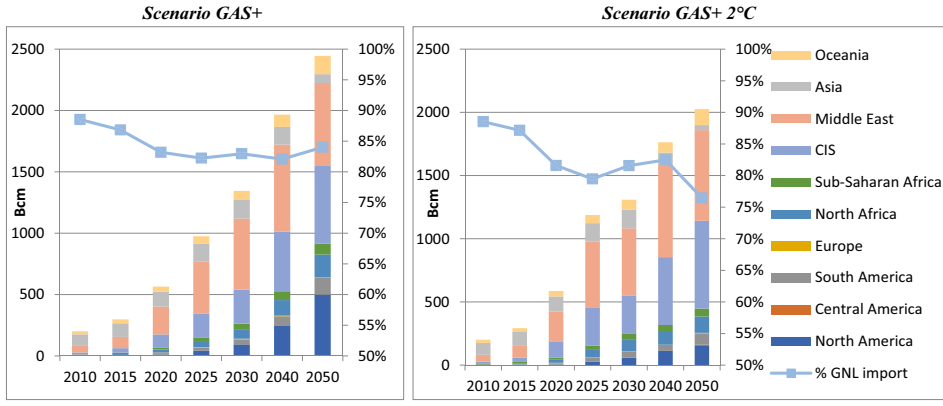

Figure 2. Natural gas imports in Asia by scenarios.

(**a**) Scenario GAS+ and (**b**) Scenario GAS+ 2°C.

Source: Result from the POLES model.

Table 3. Emissions in scenarios (*Gt CO2*)

Scenarios	*2020*	*2030*	*2040*	*2050*
GAS+				
World	656	1053	1495	1950
Asia	258	458	691	927
GAS+ 2°C				
World	649	905	1100	1251
Asia	254	371	463	540
Asia compared to the world, %				
GAS+	39	44	46	48
GAS+ 2°C	39	41	42	43

Source: Result from POLES model.

the joint reduction of CO_2 emissions and emissions of all air pollutants associated with coal. Table 3 shows the change in emissions in Asia under the POLES scenarios.

According to the data in Table 3, in the case without climate policy (GAS + scenario), the cumulative CO_2 emission by 2050 would be 1950 Gt CO_2. Asia's issuance would account for about 48 per cent of global issuance. In the case of a binding climate policy (GAS + 2°C scenario), the cumulative emissions from Asia would be limited to 540 Gt CO_2, a decrease of 42 per cent compared to the GAS + scenario. Emissions from Asia would then represent 43 per cent of the world total.

Asia increasingly dependent on gas imports

According to the scenario results, the total gas production in Asia will peak in 2040, then decrease significantly, while the gas demand will continue to increase sharply until 2050. In 2050, the domestic production of Asia will drop from 944 Bcm in the GAS + scenario to 852 Bcm in the GAS + 2°C scenario. The demand for natural gas in Asia will continue to increase to 3026 Bcm and 2477 Bcm in these scenarios. The gas supply–demand imbalance in Asia is increasingly evident. Therefore, Asia will become a major centre for

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Table 4. Natural gas imports of Asia in scenarios (Bcm)

Global gas trade	*2015*	*2020*	*2030*	*2040*	*2050*
GAS+	874	1269	2352	3138	3615
GAS + 2°C	865	1307	2246	2635	2749
Global LNG trade					
GAS+	382	626	1496	2080	2552
GAS + 2°C	376	636	1396	1780	1772
Asia's gas imports					
GAS+	298	565	1345	1966	2445
GAS + 2°C	293	587	1309	1763	2026
Asia's LNG imports					
GAS+	259	470	1115	1613	2054
GAS + 2°C	255	479	1068	1454	1549
Asia's gas imports, %					
GAS+	34	45	57	63	68
GAS + 2°C	34	45	58	67	74
Asia's LNG imports, %					
GAS+	68	75	75	78	80
GAS + 2°C	68	75	77	82	87

Source: Result from the POLES model.

importing gas into the world, mainly importing in LNG (see Figure 2). The sharp increase in natural gas imports into Asia will come mostly from China, India and Southeast Asian countries.

According to Table 4, the import of gas into Asia in 2015 represented 34 per cent of the world's gas trade or 300 Bcm. Then, it increases rapidly in all POLES scenarios. In 2050, the share of gas imported into Asia will represent 68 per cent of the world's total gas trade in the GAS + scenario. This figure will increase to 74 per cent in the GAS + 2°C scenario.

Asia imports natural gas by pipeline and in the form of LNG. In the future, the growth of imported gas by pipeline will come mainly from Central Asia, such as Turkmenistan and Kazakhstan, and Russia. However, the volume imported in this form will increase slightly due to technical and geopolitical factors. Therefore, the volume of gas imports will come mainly from LNG. By the time of our study, in all scenarios, the proportion of LNG in the total gas imported into Asia is very high, ie more than 80 per cent of the total gas imported.

4. CONCLUSION

Most of the scenarios demonstrate the important role of gas in the global energy mix in the long term. The demand for gas in Asia will grow faster than in other parts of the world. Therefore, it appears possible to imagine an extreme case in which Asia would opt for a gas route in its energy transition. This configuration would result in a scenario that shows a very rapid increase in gas demand in Asia compared to other world regions.

The main results that we have drawn from these scenarios are:

- Natural gas plays a very important role in the global energy transition in general and in Asia in particular. The demand for natural gas increases very strongly compared to other fossil fuels. The use of natural gas to replace coal, especially in the electricity sector, is rising.

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- In scenarios of binding climate policy, energy consumption decreases, the share of natural gas is still very large, but the level of gas consumption is lower than that in the reference scenario.
- The greater the emission constraint, the greater the share of natural gas, particularly in Asia.

In addition, the recent military conflict between Russia and Ukraine has greatly impacted the global energy market. Recent developments have shown that the energy market in general and the gas market in particular will shift globally. With Europe gradually giving up gas supplies from Russia, energy policies in these countries will change, and they will have to look for new energy sources. Asian countries have the opportunity to expand their gas supply from Russia, especially China and India. This will change the future energy and natural gas scenarios in Asia. However, Asia is still a region with huge growth in demand for natural gas in the world in response to economic growth as well as policies to combat climate change.

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