

FUTURE FUELLED
BY KNOWLEDGE



VOLUME 5

GAS (R)EVOLUTION IN POLAND

Which way to success?



**GAS
(R)EVOLUTION
IN POLAND**

The report has been prepared by PKN ORLEN's division of the Executive Director for Strategy, based on the CASE Scientific Foundation's report entitled "Economic potential of shale gas production in Poland in the years 2012-2025".

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COVERING LETTER



JACEK KRAWIEC

CEO, PRESIDENT OF THE
MANAGEMENT BOARD
PKN ORLEN

LADIES AND GENTLEMEN,

Welcome to the fifth volume of PKN ORLEN's "Future Fuelled by Knowledge" series, devoted to strategic economy- and energy-related issues. The present volume deals with the question of how shale gas production may potentially affect Poland's economy. It is the first time that such an extensive study of this kind has been made publicly available in Poland.

There is a widespread, and clearly justified, belief that Poland is now facing a unique economic challenge and opportunity, unlike anything it has experienced in years. We can become one of the forerunners of a wholly new sector of the world's economy – the shale gas industry. Our country stands a unique chance of becoming the first region, outside of North America, where shale gas would play a key role in bolstering the economy and enhancing the energy security, whilst significantly contributing towards a lower-emissions energy mix. By becoming

actively involved in shale gas operations, Poland will also have an opportunity to develop its own innovative technologies in the area of exploration for and extraction of unconventional oil and gas, and to ultimately become an exporter of the shale-gas R&D to countries then just starting to tap their own shale gas potential. Last but not least, which is unfortunately seldom brought up, shale gas can serve as a natural link between the old-fashioned energy sector, based on the monoculture of big producers and extensive transmission networks, and a small distributed capacity – flexible, offering greater security to consumers, involving fewer environmental impacts and incomparably more efficient.

Thus far, the public debate on shale gas in Poland has been relatively vague – both in terms of our estimated shale gas resources and the expected economic benefits of their exploitation. Poland's shale gas potential has been estimated by drawing an analogy with deposits in North America, as well as on the basis of domestic geological data accumulated over several decades for various purposes - that had nothing to do with evaluation of shale gas resources, which until very recently had been considered unrecoverable. In addition, no figures or even estimates have been published regarding the potential impact of shale gas production on Poland's economy. The effect of these information gaps is easy to predict: the bulk of opinions on whether Poland should or should not be

producing gas from shale rock are largely influenced by wishes or prejudices, rather than rigorous knowledge or even conscientious analysis of reliable data.

Hence PKN ORLEN's initiative to prepare an analysis that would provide reliable arguments to inform the on-going debate over the future of shale gas in Poland. We began the effort by asking ourselves what specific knowledge about shale gas development is yet lacking. It turned out that there was a particular scarcity of data regarding the potential long-term effect of shale gas production on Poland's economic development. This was true both of its effect on individual sectors, like the build-up of a pool of highly qualified professionals dedicated to the upstream industry, and on the whole economy, measured as an additional increase in GDP. What difference would locally produced shale gas make for Poland? What development path for the industry would deliver the greatest economic benefits? How much would we need to invest to develop the industry? How many new jobs would be created in the process? How much would the state gain in tax revenues? What could be done to turn the idea of shale gas development into a reality? Our report attempts to answer all those questions. In our search for experts we could work with on this report, we considered a number of foreign and Polish think-tanks, but our final choice was the CASE - Centre for Social and Economic Research - a renowned, independent research institution with

experienced staff and unique in Poland tools and expertise in preparing macroeconomic analyses, which cooperates with both Polish and international experts in the power and gas industries. The experts recruited for the task by CASE contributed their unique expertise in the fields of shale gas extraction technologies, the economics of the process and the regulatory environment. The result of their effort is the first comprehensive analysis of the economic potential of shale gas development in Poland, which can be found on the web pages of the CASE.

This publication relies on the findings of the CASE research. With it we have made the first major step towards a definitive answer to the crucial question - what is actually at stake in this game and what benefits the whole country stands to gain from the dynamic development of the shale gas industry? We believe that our contribution to the knowledge about the economic potential of shale gas will help both decision makers and the public at large to form their own opinions on what conditions need to be ensured for the economy to benefit from shale gas exploration and production.

Future must be fuelled primarily by knowledge, as runs the motto of our series.

I do encourage you to read on.

Jacek Krawiec

EXECUTIVE SUMMARY

Market context

- **Global consumption of primary energy grew by more than 40%** between 1990 and 2010, and is projected to increase by another **20%** by 2035. At the same time, **natural gas has been gaining in importance** – from 1970 to 2011 **its global consumption rose from 1 trillion m³ to 3 trillion m³**, and **by 2025 its share in the world's overall energy mix will have reached 25%**.
- **Conventional gas resources** are estimated at **400 trillion m³**, with more than **50%** of those total volumes concentrated in **non-democratic countries**. On the other hand, **estimates of shale gas resources are put at 200 trillion m³**, for the most part located in **more politically stable regions of the world**.
- Besides oil, **natural gas is the main fuel used by EU countries** – in 2010, **gas accounted for 25% of total energy consumed**, and that proportion is expected to increase to 29% by 2035. Over the same time – **by 2035 – the amount of gas produced in the EU will have fallen by 45%** (excluding shale gas), which will compound Europe's dependence on imports.
- **Prospects of gas production in Europe are different from those in the United States**, due mainly to dissimilar **geological, infrastructural and legal conditions**. Therefore, there is no guarantee that **shale gas will make Europe completely independent of imported gas**. Rather, it is expected to stabilise imports and make up for the declining supplies of gas from Europe's conventional sources.
- **Poland may be among the top 10 countries with the largest shale gas potential. However**, as there are plenty of possible destinations for investments in unconventional hydrocarbon production, **global capital does not necessarily have to settle on Poland**.
- **Poland is not yet ready to absorb additional supply of gas. At present, deferred demand for gas is within the range of 1.5-2.3 bn m³**. Without major investments, **it will be impossible to market volumes in excess of 5 bn m³ a year**.
- **In order to stimulate domestic demand for gas, the market needs to be liberalised**, by enabling unrestricted access to infrastructure, exchange-based trade, free choice of suppliers and trading freedom – i.e. discretion in disposing of one's own gas.

Findings of our analyses:

- The shale gas industry's **development may basically follow one of the three paths: (1)** it will be limited to

Polish operators only, without any foreign investment (**moderate growth scenario**), (2) production will be carried out by **Polish companies and, to a limited extent, by foreign players (increased foreign investment scenario)**, (3) **an investor-friendly environment** will be created (for both Polish and foreign players), **attracting an influx of direct foreign investment (accelerated growth scenario)**.

- **Polish firms** engaged in shale gas exploration and production will be in a **win-win situation regardless of which scenario prevails. Any increment in domestic gas production is set to improve their position** by reducing the volumes they are required to purchase, while the lack of strong competition under scenarios (1) and (2) will not generate any downward pressure on prices for consumers. On the other hand, intensified competition driven by **an inflow of direct foreign investment** (scenario 3) will be an opportunity for Polish firms by forcing them to **improve their development potential**, with the ultimate effect of **enhancing their competitive position** on the international arena.
- **Only the accelerated growth case** could mean a **qualitative leap for the whole economy**. Our study has found that if that scenario were to unfold **by 2025, 305 new production wells would come onstream every year,**

the volume of gas production would reach 12 bn m³, 510 thousand new jobs would be created, and the GDP growth would accelerate by 0.8 percentage point (between 2019 and 2025). This would deliver an additional stream of **business tax revenue, whose aggregate value in the years 2012-2025 is estimated at PLN 87bn.**

- **The future macroeconomic effects** of the nascent shale gas sector would include a **surge in investments and employment** within the sector itself and in cooperating industries, as well as **the multiplier effects** generating higher incomes to both businesses and households.

The aim of this study was not to **arrive at a forecast, or the most probable development scenario** for the industry, which cannot yet be foreseen with any reasonable certainty. Instead, the task we set for ourselves was to outline several plausible development scenarios for the Polish shale gas industry, including a simulation of their **economic effects**. We realised that an **important criterion for differentiating the scenarios** was the source of financing for the industry (Polish capital or an inflow of direct foreign investment). Which of the scenarios will ultimately become a reality depends on the politicians and the economic policy measures they adopt.

INTRODUCTION

Like the flow of money is the life blood of economy, so energy sources are the foundation of its growth. Improbable as this may seem, according to William St. Jevons, as the efficiency with which energy is used increases, so does the rate of its consumption by the economy. This is why a country's supply of energy and ability to use it in an economically viable way is an important driver of economic wealth and growth. This is a major reason why the richest and most developed economies, which have already depleted their easily recoverable reserves of energy, started to develop first nuclear assets, and then renewable energy sources, having in recent years added to the two development directions intensive work on exploiting resources hitherto considered "unrecoverable".

The findings of research linking the man-generated spike in greenhouse gas emissions to global warming have added a new dimension to RES development programmes, turning them into a weapon to combat global warming and putting them among the top priorities in development of energy sources. The realisation that we may be sitting on new, abundant resources of recoverable gas, trapped in shale formations, is changing that perspective. Appreciating the role of natural gas in the decades to come, the International Energy Agency (IEA) is announcing the advent of the golden age of gas. With its rich shale deposits, Poland may use its shale gas not only to effect a shift in energy consumption towards a low emissions model, but also leverage the unconventional hydrocarbon E&P segment as a powerful driving force propelling its economic growth in the years to come. Polish shale gas is a new magnet for direct foreign investment, underpinning the success of the Polish transformation effort.

MARKET CONTEXT

PLACE OF NATURAL GAS IN THE GLOBAL AND EUROPEAN ENERGY MIX

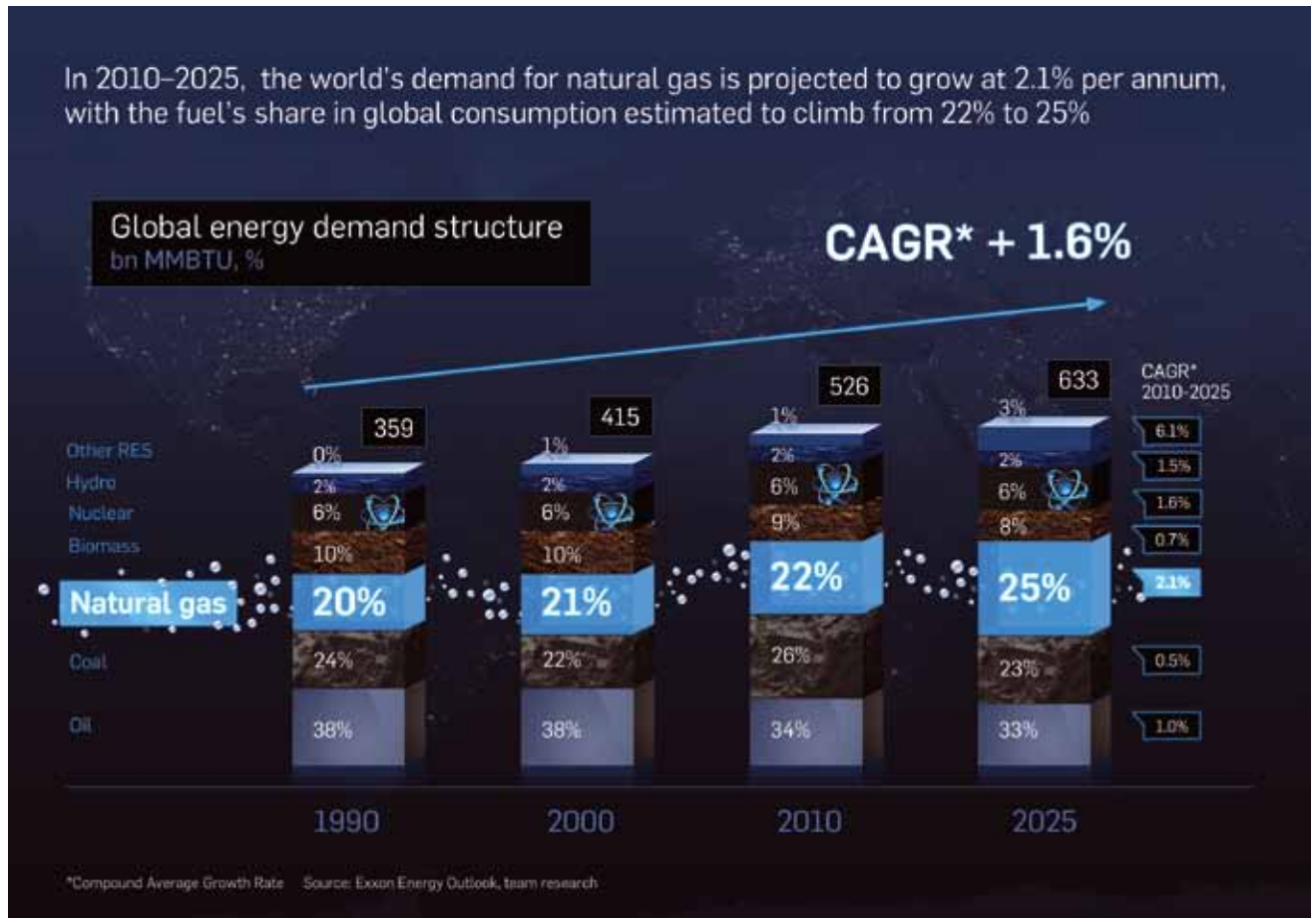
Global primary energy consumption rose by 46% between 1990 and 2010, and it is projected to surge by another 20% from 2010 to 2025. The surge will be propelled by emerging economies, as demographic factors and economic growth potential are among key drivers of energy demand. Although the share of renewable energy in total consumption is on the rise, hydrocarbons are bound to remain the primary source of energy. By 2025, fossil fuels are expected to account for some 80% of total energy consumption. What is expected to change considerably is the consumption structure: the share of coal will shrink the most as – due to high carbon emissions – it is the first to be replaced by RES and nuclear energy sources. The importance of crude oil will also decline gradually. Demand for electricity (rarely produced with the use of crude oil) will be rising faster than demand for transport (fuelled chiefly with oil refining products).

Undoubtedly, natural gas is the fuel of the future, and it will gain in importance for two principal reasons:

1. it is the cleanest of all fossil fuels, and
2. it is becoming increasingly recoverable thanks to the rapid progress in new technologies that facilitate extraction from offshore deposits and rock formations.

Importantly, unlike many renewable energy technologies, conventional gas assets bring fast returns on investment and create new jobs for the entire economy rather than just one sector. After all, there must be a valid reason why petroleum supermajors, collectively dubbed Big Oil, have already started to refer to themselves as Big Oil & Gas: in the next two or three years natural gas will represent 40% of their overall output.

It is a common fact today that natural gas is abundant around the world, with recoverable conventional gas resources estimated (with 90% confidence) at over 400 trillion m³, which should be enough to satisfy over 120 years of consumption growing at the currently predicted rates. Although for decades gas has been known to



be trapped inside shale rock, development was not commercially viable until late 20th century. Technically recoverable reserves are now estimated at over 200 trillion m³. Thus, the world's known gas reserves have increased by around 50%, which means that the risk of full depletion of gas resources has been deferred for at least another 60 years.

From 1970 to 2011, global gas consumption grew more than threefold – from 1.0 trillion to 3.3 trillion m³. Global gas production hit a new all-time high in 2011. Today, gas used by the U.S. alone is equivalent to the world's total consumption back in 1965.

Not only has the increased availability of natural gas changed the makeup of global energy mix, but it also has caused a shift in the resource-driven geopolitics

In common with oil, conventional gas resources are concentrated in the non-democratic regions of the world: non-democratic nations hold 50% of recoverable gas. Concerns over the security of supply from these sources have made importers naturally inclined to lower the share of natural gas in the overall energy mix.

In addition, the average price per thousand m³ of natural gas in Europe rose from USD 135 in 2000 to USD 470 in 2008, greatly contributing to the accelerated

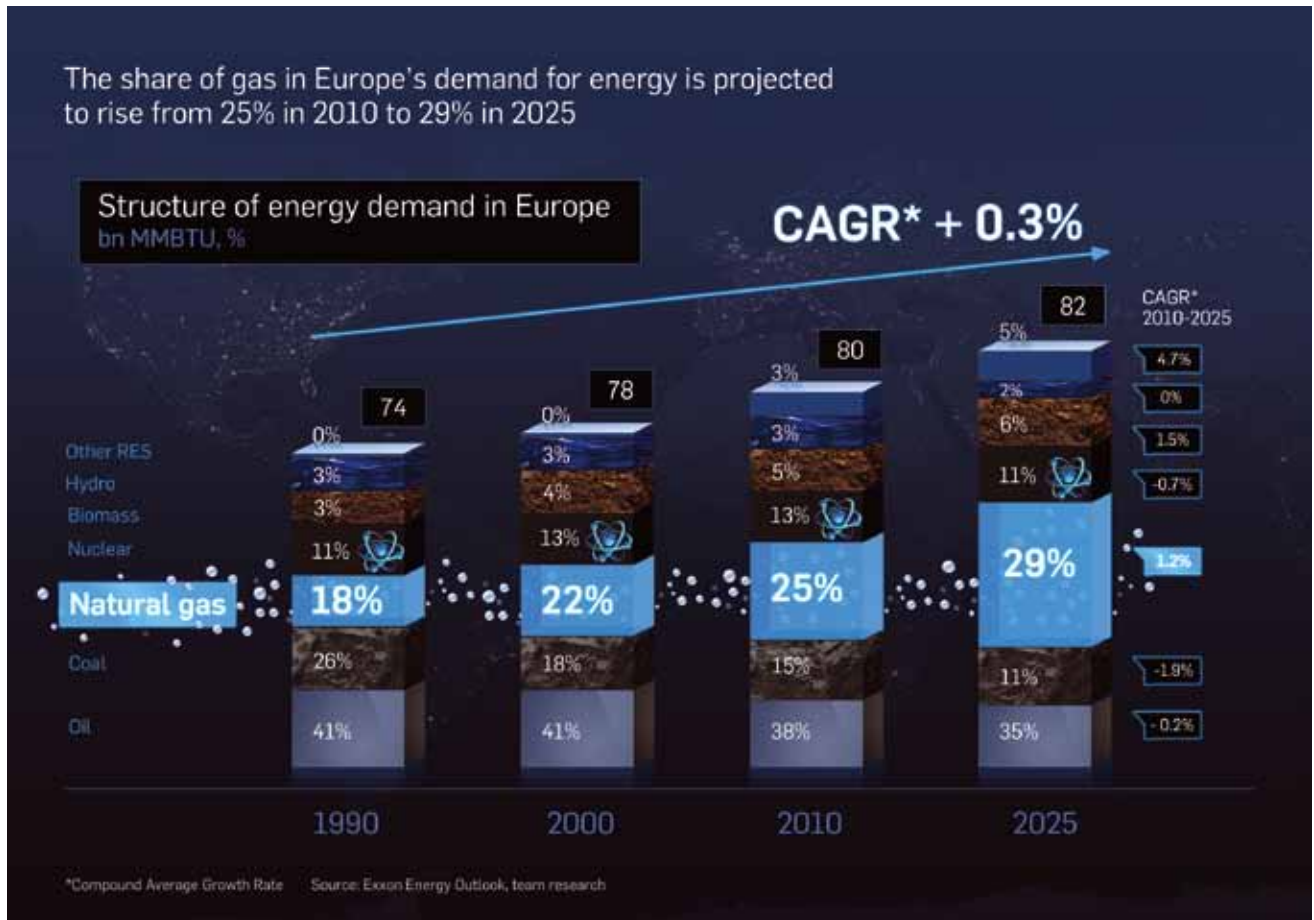
development of the renewable energy sector. The key factors in this respect included imposition of the 20% target for renewables in the EU climate package (20-20-20) and increase in the level of subsidies. As fossil fuel prices were expected to continue their upward march at the time (upon prospects of imminent resource depletion), it seemed to be only a matter of time that RES technologies would start to be commercially viable, which in turn legitimised the subsidies. The global recession heavily affected the capacity to subsidise RES assets whose construction costs continue to be far above the costs of fossil-fired energy generation. The earthquake and the Fukushima nuclear plant disaster suffered by Japan in 2011 have reignited the fears associated with nuclear technologies. The shale gas boom in the U.S. and the related sharp decline in gas prices was a game-changer in the energy sector, which also depressed gas prices in Europe through the ample supply of cheaper LNG. With the advancement of hydraulic fracturing, natural gas suddenly became available to developed economies (seven out of ten countries sitting on the largest shale gas deposits are developed economies). With all these factors combined, natural gas is projected by the International Energy Agency to become, in 2025, the second most important fuel after oil.

Contrary to popular belief, the sagging prices and the increasing role of gas in the energy mix poses no threat to targets set in the war against climate change being attained. Considering the obstacles encountered in attempts to shift the global economy into a low-emissions mode and reduce carbon footprint through application of selected RES technologies (which still need to be subsidized with funds taken out of the ever-thinner wallet of the taxpayer), the only viable way to curb greenhouse emissions is to promote development of gas-fuelled generation assets. The burning of natural gas produces 40% less of carbon dioxide than coal and 30% less than crude oil. As shale gas deposits are more evenly distributed than conventional resources and technological progress has made development commercially viable, gas-powered energy has the potential to facilitate the achievement of the climate objectives.

Low-price gas is no threat to the development of RES technologies. Just the opposite. It buys the precious time and unties funds that may be spent on energy innovations (instead of being thrown at RES assets with no economic viability, the taxpayer's money can be applied towards technological advancement by financing R&D efforts). Moreover, depreciated gas-powered plants present a cheaper option to complement future solar and wind-powered generation than new gas-fuelled plants erected for that purpose. Lastly, shale gas is bound to promote growth of distributed generation. The geological dispersion of shale gas deposits will naturally foster the development of distributed generation and help persuade the public that multiple energy sources integrated into an intelligent grid offer greater service reliability than any single producer running the risk of technical failure that could disrupt the entire system.

Natural gas is fundamental to the EU's energy balance

Just after crude oil, natural gas is the main fuel used by the EU 27 countries; its share in the primary energy consumption structure in the EU 27 is approximately 25%. By 2025, the fuel is expected to account for ca. 30% of the consumption. This upward trend means that – in the absence of investments in hydrocarbon production assets – natural gas and crude oil will continue to be the fuels which make the EU dependent on energy imports to the largest extent. It is projected that in 2010–2035 natural gas consumption in Europe will rise by 50 bn m³ (565 bn m³ in 2035 vs. 515 bn m³ in 2010). Over the same time, the amount of gas produced in Europe is expected to fall by 79 bn m³, i.e. nearly 45% (to 97 bn m³ in 2035, from 176 bn m³ in 2010). This will add a further 29 bn m³ to the demand for imported gas. The key sources of primary energy imports to the EU 27 are Russia, Norway and Algeria. However, the geographical structure of imports varies strongly among the member states. Imports by the EU 15 countries are much more diversified compared with the new member states, which continue to source their crude oil and natural gas supplies almost entirely from the eastern direction, as they did under the CMEA.



CONDITIONS FOR SHALE GAS DEVELOPMENT – UNITED STATES VS. EUROPE

Thanks to intensified production of gas from unconventional deposits, the United States has become the world's leading natural gas producer, having overtaken Russia: in 2011 natural gas output in the United States was nearly 650 bn m³, compared with 589 bn m³ in Russia. Over the same period, gas output in Poland was 4.3 bn m³. Although a vast majority of the natural gas produced in the United States comes from conventional sources, unconventional gas (shale gas, tight gas and coal bed methane) is growing in significance. Particularly evident is the growing production rate of shale gas, which accounts for nearly 20% of the total natural gas production in the United States (2000: only 1%). The year-on-year production growth rate is also

impressive: the 2010 output was 150 bn m³, compared with 10 bn m³ in 2000. It is expected that by 2020 shale gas will account for approximately 50% of the total gas production in the United States.

To note, the United States has not yet become fully self-sufficient considering the country's demand for natural gas, but its dependence on imports is being significantly reduced. In 2011, net gas imports totalled 55 bn m³, compared with 68 bn m³ in 2010 (down almost 25%). The higher unconventional gas production in the United States has resulted in a 15% drop in gas imports over four years and a 30% decrease in the use of LNG terminals. An excellent example of the trend is the Freeport LNG terminal, constructed on the American East Coast in 2005–2008. Since its completion, no transport tanker has arrived at the terminal and over a

half of the American East Coast's loading capacity has been idle. The production of unconventional gas has also contributed to a significant decline in gas prices and has helped to eliminate seasonal gas price fluctuations.

The case of Europe is different from that of the United States, mainly due to the geological, infrastructural and legal conditions. Therefore, there is no guarantee that shale gas will make Europe completely independent of imported gas. Rather, it is expected to stabilise imports and make up for the declining supplies of gas from Europe's conventional sources.

The development of the American shale gas resources and the resulting increase in gas supplies has led to a significant drop in natural gas prices, which fell below USD 100 per thousand m³. Cheap gas has become an important driver of the U.S. economy, as it encouraged investment in energy-intensive industries. Lower gas prices also helped to reduce household costs, which in turn boosted consumer spending. It would not be an exaggeration to say that the recent financial crisis in the United States would have been much more profound and devastating if it wasn't for the breakthrough in shale gas production.

At present, long-term gas contracts in Europe tend to be inflexible and set gas prices at high levels. Under the prevailing mechanism, in long-term contracts gas prices are indexed to the crude oil price. In essence, this has three underlying causes:

1. There is no single European market where prices of gas would be determined by reference to other gas markets,
2. Therefore, gas supplies (and prices) must be determined in multi-year contracts,
3. Historically, crude oil has been a close substitute for gas (the existence of gas- and oil-bearing deposits means that oil may be substituted with gas in the heat and power industries).

The discovery of shale gas in North America and the resulting decline in the continent's demand for LNG has led to a slump in LNG prices across Europe. The historically strong correlation between the prices of LNG and pipeline gas has been gradually weakening. In the future, gas prices are expected to be increasingly

determined on the European market, independently of the prices of crude oil, as is now the case in the United States and Canada.

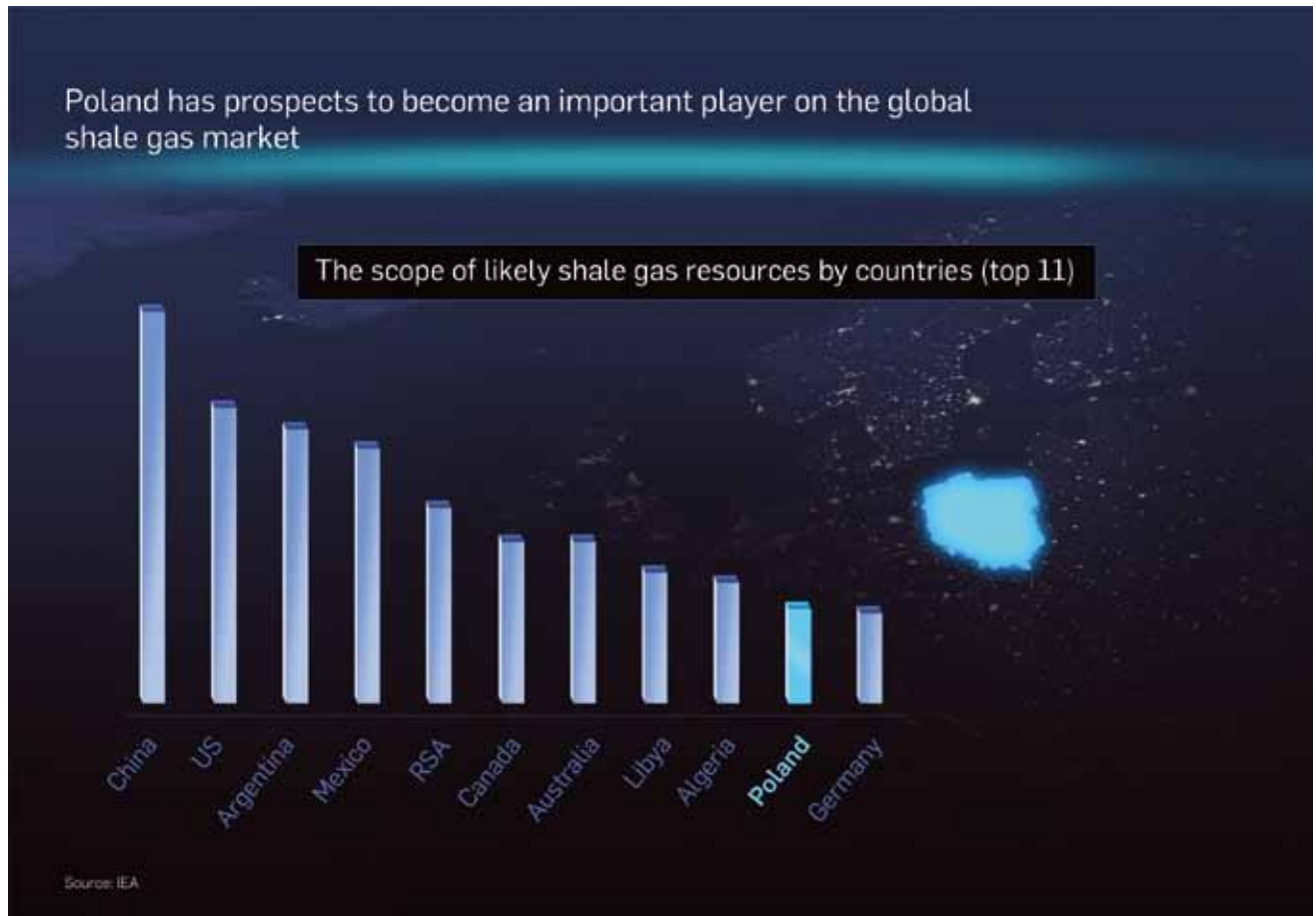
An analysis of the sources of gas supplies to Europe points to three key supply streams that determine the volume and prices of gas on that market:

1. gas imports through pipelines, with Russia being the main supplier;
2. trade in LNG;
3. developing production of gas from unconventional deposits.

Over the short term, the three supply sources will be competing with each other (gas-to-gas competition). However, if we look at a longer time period and combine the three sources into a single one with one market-determined price, gas supplies should in fact become a competitive alternative to coal, RES and nuclear power. We know that demand for gas will be growing. More advanced shale gas production technologies will increase gas supply on global markets, leading to stronger competition and lower gas prices. This, in turn, will make the entire gas sector well-positioned to compete with other fuel industries. Therefore, the competition between gas market participants, driving prices toward a single market price, is not a zero-sum game.

POLAND AMONG COUNTRIES WITH THE LARGEST SHALE GAS POTENTIAL

Unlike the location of conventional gas resources, the geographical distribution of potentially gas-bearing shales to a large extent matches the areas with of the highest gas consumption. The largest unconventional gas resources are found in China. Poland's resources, although considered one of the largest in Europe, are not substantial from a global perspective. According to estimates of the International Energy Agency, Poland may be among the top 10-15 countries with the largest reserves of shale gas in the world. The preliminary and widely divergent estimates provided by different sources may not serve as a conclusive argument in defining a strategy for the shale gas industry's development. These estimates show, however, that in its effort to secure partners experienced in shale gas production

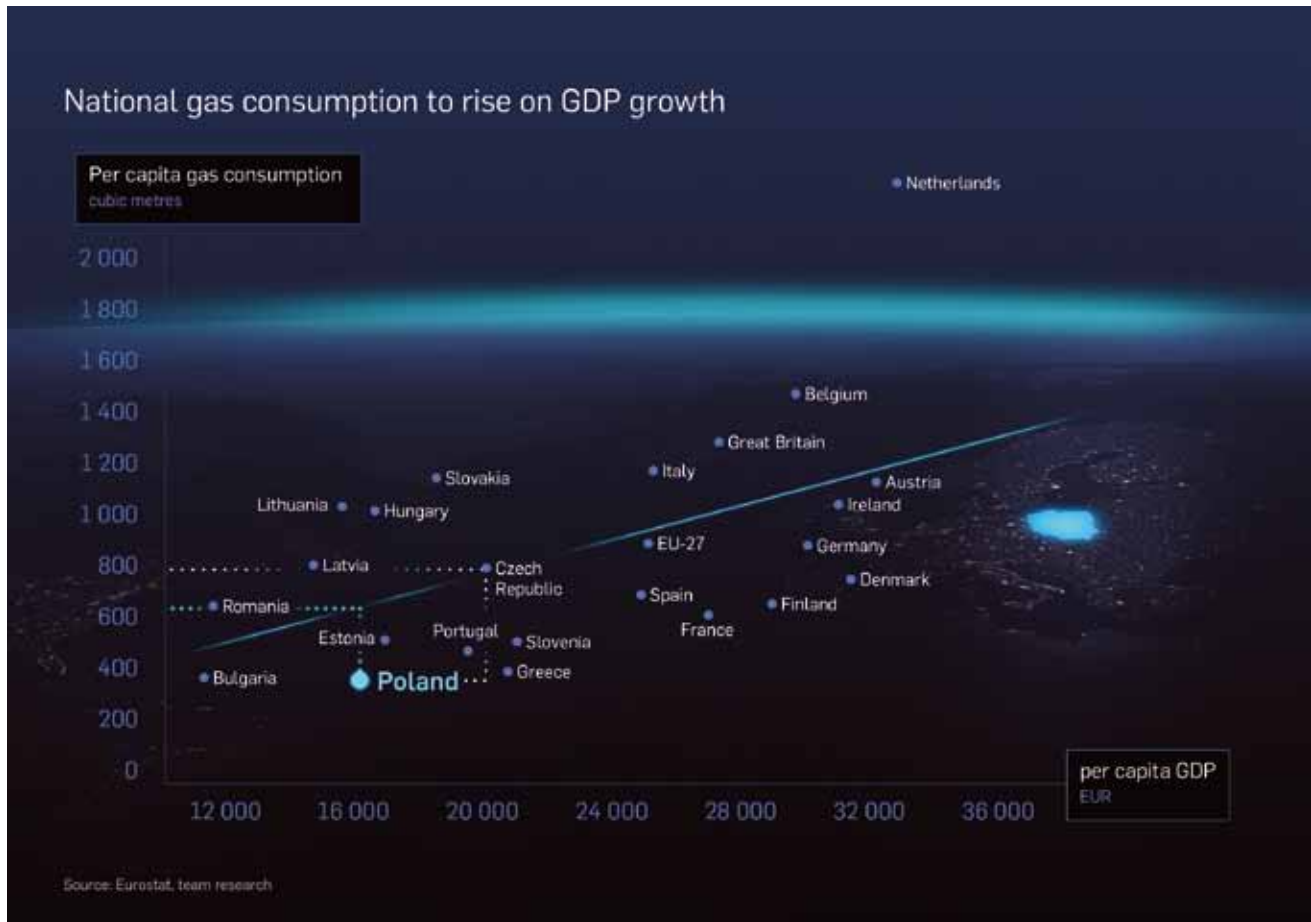


Poland competes with non-EU economies, which offer potentially more favourable conditions for production operations – compared with very strict EU regulations concerning environmental and climate protection, employment, or certification of non-EU machinery and equipment, which all directly affect costs of E&P operations.

It has been known for many years that there are considerable shale deposits in Poland. Following the commercial success of shale gas production technology in North America, the shale gas rush reached Poland a few years ago. It was first manifested in the preparation of estimates of gas trapped in shale deposits across Poland. According to preliminary estimates, based on historical geological data collected from wells drilled for purposes other than shale-gas exploration and by reference to

shale gas deposits in North America which had already been appraised, unconventional deposits may hold from 370bn to 5.1tn m³ of natural gas. Depending on the source of estimates and the assumed consumption levels, shale gas deposits could be sufficient to satisfy Poland's needs over the next 200 years. However, one has to bear in mind that the process of appraising potential shale gas deposits in Poland is at its early stages and the estimates of resources depend not only on the quality of deposits and production cost per cubic metre of gas, but also on the price at which shale gas may be sold to end customers.

In Europe, Poland ranks among countries where natural gas consumption is low, which results both from the abundance of coal and lignite as well as from historical perception of gas as a rare natural resource that may be



used only where this is absolutely necessary. Poland's annual consumption, at approximately 400 m³ per capita, is well below that of top consumers, such as the Netherlands (2,285 m³), the United Kingdom (1,284 m³) or Italy (1,177 m³); it is also below the average consumption in the EU member states with similar per capita incomes (among which Poland ranks fifth but last in terms of gas consumption). However, by developing its own gas reserves Poland may quickly increase its level of gas consumption per capita to catch up with the EU-average, and given the concurrent increase in per capita income, the potential growth of demand may represent even a two-fold increase relative to the current gas consumption.

WHAT CAN BE DONE TO INCREASE THE CHANCES OF UNLOCKING THE SHALE GAS POTENTIAL

For the shale gas potential to be fully leveraged, preparations are necessary on the demand side. Although experts estimate that with relatively small expenditure on the distribution infrastructure Polish households and the industry (excluding the power sector) could absorb a further 1.5-2.3bn m³ of gas, it will be impossible to market an additional 5bn m³ or more of gas without prior major investments, e.g. in power generation.

However, the goal of expanding the market will be impossible to achieve without further liberalisation of the market. On markets with a greater variety of gas sources and suppliers than has so far been the case in Poland, a deregulated gas market is the predominant

model. Also the policy favoured by EU institutions is going in that direction, as efforts are under way to create a pan-European gas market.

The course of liberalisation reforms should be overseen by an adequately empowered regulator. In addition to monitoring Poland's evolution towards a free gas market, the regulator should also stimulate that shift and have the authority to censure any monopolistic practices. Failing such an impulse and strong support, the market may become bogged down where it is now, as a single-supplier market can hardly be expected to have any genuine interest in deregulation.

To be called truly liberalised, the Polish gas market must have several key characteristics. They will attract new market entrants, making it possible to unlock the potential of new gas players.

First of all, no single market player should enjoy a competitive advantage stemming from privileged access to infrastructure. On an efficient gas market, no operators are discriminated against and the infrastructure is accessible to all of them on equal terms. In order to ensure such a free and unrestricted business environment, it is necessary to separate gas production and sale from the operation of infrastructure, subject to effective regulatory oversight. It is also advisable to design a mechanism aimed at curbing the monopoly on cross-border interconnectors, where dominance would have a particularly harmful effect on the free market.

Enterprises operating in the gas industry seek access to liquid markets, on which purchases and sales can be transacted in a simple way and at a low cost. Such access may be facilitated by a virtual trading point combined with a gas exchange, serving as a platform via which suppliers can easily sell their product, while buyers can choose from among a number of competitive suppliers. A gas exchange provides a market pricing mechanism, while promoting transparency. It can rely on solutions previously tested e.g. on the power market.

Customers must have the actual and flexible option to terminate or modify their gas supply contracts. Long-term contracts, which are still concluded in Poland

while being obviously a relic of the past, have an adverse effect on the demand side of the market, preventing new suppliers from effectively competing with the incumbent monopoly. An option to terminate long-term contracts is a prerequisite for the gas market to develop, as without the freedom of contract no liberalisation effort can be successful and no new suppliers can emerge. It should also be remembered that, until they secure a fully alternative supplier to the incumbent monopoly, customers should be able to partly change suppliers, without having to terminate in whole their existing contracts with the incumbent.

A growth-oriented gas market is a market where the right to trade in purchased gas fuel is in no way restricted by suppliers. Accordingly, no-resale clauses should be made illegal by virtue of the anti-trust laws, as they expressly preclude competition with the supplier by prohibiting buyers from actively trading in the product they have purchased.

There is no doubt that the gas market's liberalisation will be a complicated task, and one carried out on a living organism. It is crucial to ensure that any measures taken to achieve that end are consistent and bold, as nothing short of that can prepare the Polish gas market for a potential expansion.

We need to think now who could buy potentially large amounts of shale gas, how to transport the gas, and how to modify governmental and private investment programmes to account for these changes. This is a demanding task as activities on the demand side will have to be planned without any certainty as to the size of shale gas resources. However, we cannot wait until the shale gas potential is confirmed because our inactivity in this respect will adversely affect economic viability of exploration and production efforts. It is hard to make decisions concerning large-scale gas production (of several billion m³ per year) if there is no visibility on sales of the gas to end customers. This will be a particularly important consideration in the case of foreign companies – potential direct investors in shale gas production. By contrast, it will not be an issue for large Polish explorers, as they already rely on gas imports, which they will simply replace with domestically produced gas.

From exploration to extraction

Although natural gas is a natural resource and the gas industry in the EU is classified as a production industry, the experience of U.S. companies shows that the stage of exploration for and production of shale gas in the United States and Canada had all the features of innovative start-ups: experimenting in search for the most suitable technology, high level of risk (beyond typical business risks), and long payback periods. On the other hand, if successful, the investments offered high returns. That is why little-known and independent oil companies, such as Chesapeake Energy, East Resources, XTO Energy or EOG Resources, supported by venture capitalists, were the first to drill down to the shales in the 1980s. Global majors, which usually do not engage in such innovative projects, did not enter the shale gas sector until production had been documented and when relevant risks could be evaluated,

and they did so by taking over assets from companies which had already discovered shale gas deposits. It was not long after the majors, unmatched at cost cutting, arrived in the shale gas sector that the U.S. market saw a rapid and steep decline in production costs and gas prices. By August 1st 2012, 111 licences for unconventional gas exploration had been issued in Poland, of which 35% have been granted to Polish companies and 65% to foreign entities. By the end of July 2012, 25 exploration wells had been drilled. The area of exploration for unconventional resources covers approximately 20% of the territory of Poland, i.e. some 60,000 km² (14.83 million acres). The shale gas belt spreads from the coastal area between Słupsk and Gdańsk towards Warsaw and further south to Lublin and Zamość. Potential shale gas deposits are expected to be found at the depth of 1,200-3,000 m in the northern section of the belt, and 4,500 m in its southern part.

PKN Orlen is among leaders in shale gas exploration

Lublin Shale Project

- 2 vertical wells drilled (Wierzbica and Lubartów)
- 7 wells planned to be drilled in 2012 (including two horizontal) in the Garwolin, Wierzbica and Lubartów licence areas
- 2 drilling platforms contractually secured, to be used in the second half of 2012

Hrubieszów Shale Project

- Geological data planned to be acquired and interpreted in 2012

Mid-Poland Unconventionals Project

- Plans for 2012 include reinterpretation of the existing seismic data and working out a methodology to acquire new seismic data in 2013

Lublin Shale Project:

1 Lublin 2 Garwolin 3 Lubartów 4 Wierzbica 5 Bełżyce

Hrubieszów Shale Project:

6 Hrubieszów

Mid-Poland Unconventionals Project :

7 Sieradz 8 Łódź

One of the leaders of the shale gas market in Poland is PKN ORLEN, which holds eight exploration licences covering the Lublin and Mazovia regions with a total area of 4,700 km² (8% of the total licence area).

Organic work

Poland may have large reserves of natural gas, but that alone is not enough to ensure that its economy will make a major leap forward – such progress will depend, on the one hand, on the volume of commercially viable gas production, and on the other hand on the effectiveness of know-how acquisition and ability to use the newly acquired knowledge to develop a national shale gas industry. This dependence is demonstrated by the example of a number of hydrocarbon-rich countries that have not engaged actively in acquiring know-how or building their own gas industry, thus wasting an opportunity to make the gas sector a powerful driving force propelling their economic growth. In order to effectively develop the potential reserves of unconventional gas, Poland will need to address a number of serious challenges. Only capable management of the development of unconventional gas production will strengthen Poland's position on the international energy market, also increasing its economic and political clout.

Shale gas production forms part of the gas sector rather than an autonomous industry. Since our reserves of conventional gas, which could lay foundations for the development of unconventional gas, are scarce, we need to make a huge effort to create the shale gas industry in Poland. We must focus on infrastructural development. We are facing the challenge of building the sector starting from scratch: both the upstream segment and the market for newly produced gas. We must also create demand that would guarantee the commercial viability of the upstream business (infrastructure and regulations, as well as the energy strategy). In order to maximise the benefits of shale gas exploration and production we must enhance our economy's ability to learn the know-how through appropriate cooperation between domestic and foreign businesses and academic centres. Technologies of shale gas exploration and production are still under development, therefore the Polish industry and scientists may and should play an active part in the process.

The commercial viability of upstream activities depends on efforts undertaken on the surface

The commercial viability of shale gas production, determined by assessing the quantity of gas reserves in shale, is driven by both supply and demand factors. The supply-side factors include unit production costs, which depend on geological characteristics of reserves as well as exploration and production technologies applied to develop the reserves. Supply and demand factors change constantly, and so do the estimates of recoverable reserves.

The demand-side factors with a bearing on commercial viability of production include the marketing conditions for produced gas: effective demand (Is there the final user to purchase the gas?) as well as the manner and cost of gas delivery from the place of production to the final user (Is there gas infrastructure suitable to accommodate additional large gas quantities?).

Shale gas extraction technology still under development

It is commonly believed that the technology of shale gas exploration and production has been developed, patented and is now available to anyone who wants to use it. This belief is only partly true as many elements comprising the technology (3D seismic surveys, directional drilling, fracking techniques, composition of fracking fluids and proppants) are still at an experimental stage and under development due to the necessity to adapt to diverse geological conditions and conditions on the surface (such as road infrastructure, land development, population density, environmental conditions, or water availability). Consequently, while certain technology variations work for one site, they fail in the case of another. Selecting appropriate technologies for a given site is a critical decision affecting the costs and commercial viability of production. Only few have the necessary expertise. Accordingly, experts are of the opinion that if a well is found to be dry, it is not necessarily so due to its very nature but possibly due to the use of a specific technology.

RESEARCH FINDINGS

NEED FOR INVESTIGATION INTO ECONOMIC IMPACTS OF SHALE GAS PRODUCTION

The public debate on Polish shale gas touches upon a variety of issues. Opinions are voiced by geologists, environmentalists, climate experts, economists and politicians. The most frequent questions concerning the economic aspects of shale gas production in Poland are:

1. How much shale gas is there in Poland?
2. Will it be commercially viable to produce shale gas in the country?
3. Should we produce gas on our own or allow foreign players?

No one needs to be convinced that without a thorough economic analysis placing the answers in the context of coherent demand and supply considerations and taking account of limited financing availability, any responses now being offered are expert opinions addressing only a part of the issues. On the other hand, the questions that have been asked undoubtedly deserve to be answered in earnest.

With this goal in mind, PKN ORLEN began to look for an institution which would be able to perform a research into the economic potential of Polish shale. Combining the North American experiences, geological and gas sector expertise and economic viability considerations and analysing the information in the context of the future of the entire national economy proved a considerable challenge. The task was finally assigned to CASE – Centre for Social and Economic Research, which, as an experienced sector and macroeconomic analyst, brought in recognised foreign and Polish experts to participate in the project. The work, which commenced in early March 2012, has yielded a report entitled “The Economic Potential of Shale Gas Production in Poland in 2012-2025. Scenario Analysis”.

There is no way we can analyse the entire spectrum of possible scenarios for the Polish gas sector and their potential impact on the economy. It is therefore necessary to focus on a few possible scenarios providing an ample demonstration of the choices to be made by decision makers.

Rationale behind the selection of scenarios for gas sector development in Poland

When developing the scenarios, it was not our intention to create projections for the shale gas business in Poland or to determine the most probable course of events. We cannot do this due to huge uncertainties in the economic environment, very scant data, and fragmented knowledge of the shale gas business.

Instead of taking a guess at what will be, we have posed a different question, also applying to the future but in no way determining its shape.

Since a long time will pass before we know the quantities of gas in Polish shale, we have made a silent assumption that there is gas in Polish shale (since what actually lies underground is beyond our control), thus leaving the geological uncertainty outside the scope of research. Still present in our analysis, the uncertainty is addressed in the risk assessment section.

We have asked experts how much gas can be extracted countrywide considering the available financing. Since the answer depends on the size of financing, we have arrived at an important criterion for differentiating the scenarios: Who will finance exploration and production throughout Poland?

The answer to the question led to transition from the level of particular companies financing individual wells to the macroeconomic level and, consequently, to the development of various scenarios depending on whether the development of the shale gas sector is to be financed mainly by Polish companies or whether foreign players are to be allowed as well. In the latter case, the scale of financing of shale gas exploration and production by foreign investors will depend on the funds they will be willing to commit to their investments in Poland. If investors' readiness to invest in Polish shale gas was higher than the absorption capabilities of the new sector, the scale of financing would be determined only by purely technological limitations, namely the number of production wells that can be drilled by 2025.

The spectrum of possible scenarios ranges from a scenario in which shale gas production is financed by Polish companies only (moderate growth scenario) to a scenario where foreign businesses engage in exploration and production in Poland on the largest scale that can be imagined today, determined by technological constraints and commercial viability (profitability) (accelerated growth scenario).

The decision which of the scenarios is to be pursued will depend on how politicians set the economic policy instruments, including direct measures, such as procedures for exploration and production licensing or regulations liberalising the gas market; and indirect measures, such as the form and scale of taxes imposed on gas production.

The research analyses two extreme scenarios (moderate growth scenario and accelerated growth scenario) as well

as one medium scenario (increased foreign investments). Already during the research phase it transpired that the medium scenario's position relative to the extreme scenarios also depends on certain governmental actions, namely those creating demand for additional gas. Such actions are indispensable in the scenarios assuming large-scale shale gas production as there will be no large-scale production if the end consumer is not known.

Large gas quantities could be sold to the power sector and/or exported. To stimulate demand for gas among power sector and export buyers, appropriate power sector and gas infrastructure development programmes must be prepared in advance. On the other hand, such plans cannot be drawn without knowing the productivity of Polish shale gas reserves. For this reason, one of the important conditions for the high scenarios to arise is coordination of demand-stimulating efforts with the progress of exploration and production.

Moderate growth scenario	Unit	2012-2018	2019-2025	2012-2025
Exploration				
CAPEX	USDbn	0.7	-	0.7
Workforce (annual average)	thousand	0.9	-	0.4
Exploration wells converted to producing wells				
Number of wells		65	155	220
CAPEX	USDbn	0.8	1.8	2.6
Workforce (annual average)	thousand	1	2.9	1.9
New producing wells				
Number of wells		30	270	300
CAPEX	USDbn	0.4	4.2	4.7
Workforce (annual average)	thousand	0.4	3.2	1.8
Total CAPEX on shale gas exploration and production (shale gas investment)	USDbn	1.9	6	7.9
Total workforce associated with shale gas exploration and production (shale jobs)	thousand annual average	2.2	6.1	4.1
Shale gas output (at end of period)	m m ³	1,032	3,519	3,519

THREE PATHS FOR DEVELOPMENT – SCENARIO INTERPRETATION

The scenarios depict plausible development paths for the shale gas sector and describe different situations depending on various assumptions concerning possible economic policies. Both conditions and scenarios must have one feature: the conditions must be plausible and the scenarios must be plausible in the context of the conditions.

Assuming the presence of recoverable shale gas in Poland, the shale gas sector in the country may follow three alternative development paths, substantially depending on the shape of its environment in the near and more distant future. Creating a development strategy for the shale gas sector in Poland and the related efforts to shape institutional, regulatory and tax environment is the domain of economic policy. As it is impossible to apply scientific measures to predict the choices of decision makers, it is also impossible to objectively point to more or less plausible scenarios.

Moderate growth scenario

One plausible scenario is that gas is produced only by domestic firms. This path may be selected both as a result of a deliberate political choice (“Polish gas in Polish hands”) or may be a consequence of implementing a tax and legal regime not acceptable to foreign investors.

In the moderate growth scenario, Poland develops gas exploration and production in line with its domestic investment and staff capabilities, importing available technologies and engaging the small number of shale gas production specialists available on the global market. Between 2012 and 2025, investment of approximately USD 8bn in shale gas exploration and production will result in 520 production wells, including 425 wells drilled in 2019-2025 (61 wells annually on average). In 2020, the volume of gas produced from this number of wells will exceed 2.2bn m³, to reach 3.5bn m³ in 2025. Further investments of approximately USD 0.8bn annually (60 wells annually) will stabilise gas production at this level.

Increased foreign investment scenario	Unit	2012-2018	2019-2025	2012-2025
Exploration				
CAPEX	USDbn	0.7	-	0.7
Workforce (annual average)	thousand	0.9	-	0.4
Exploration wells converted to producing wells				
Number of wells		65	175	240
CAPEX	USDbn	0.8	2	2.8
Workforce (annual average)	thousand	1	3.2	2.1
New producing wells				
Number of wells		30	500	530
CAPEX	USDbn	0.4	7.2	7.7
Workforce (annual average)	thousand	0.4	6	3.2
Total CAPEX on shale gas exploration and production (shale gas investment)	USDbn	1.9	9.2	11.1
Total workforce associated with shale gas exploration and production (shale jobs)	thousand annual average	2.2	9.1	5.7
Shale gas output (at end of period)	m m ³	1,032	5,934	5,934

Increased foreign investment scenario

Another option is to allow foreign players to participate in shale gas exploration and production while maintaining the dominant role of Polish investors. The business environment created in Poland will encourage some foreign businesses to establish a limited presence in Poland as long as such a move is consistent with their business strategy. However, no foreign firms will develop their business strategies based chiefly on Poland and its shale gas resources.

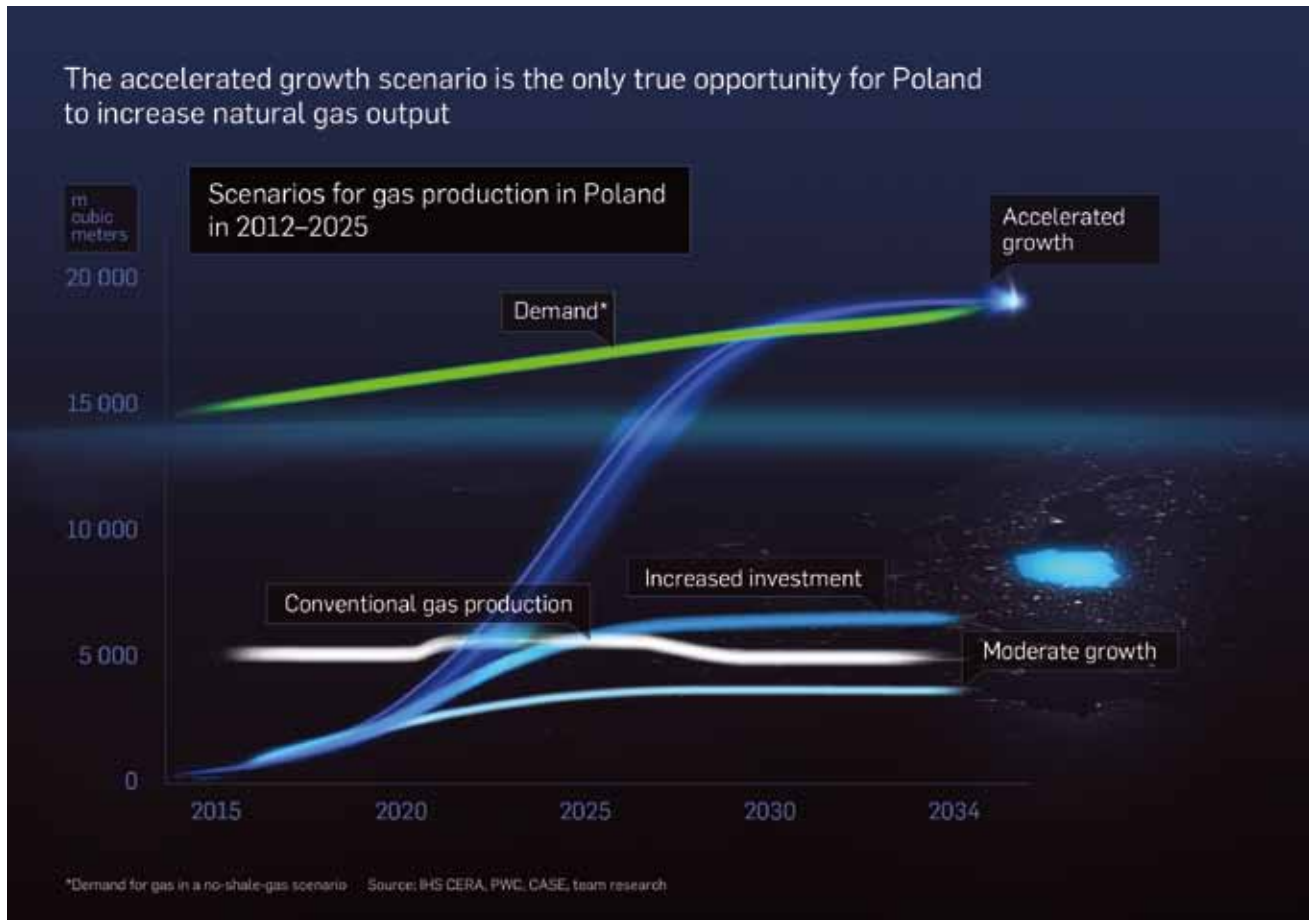
In this scenario, in 2012-2025 Polish economy spends USD 11.1bn to finance a total of 770 wells (including 675 wells in 2029-2025 – 96 wells annually). Gas production in 2020 amounts to 2.6bn m³, to exceed 5.9bn m³ in 2025. Further annual investment spending of USD 1.5bn will finance the production launch of 105 wells annually, which by 2034 will stabilise gas production at 6.4bn m³.

Accelerated growth scenario

Under the third scenario, in addition to the strong involvement of Polish investors, the market becomes fully open for experienced foreign companies. To ensure their participation, an investor-friendly legal and tax system must be created. Such system must mitigate the risk investors take by engaging in exploration and production on a market new to upstream activities. For this scenario to come to pass, the government must take active steps to liberalise the gas market, create demand and build infrastructure, all this to be achieved by creating appropriate energy sector development programmes providing for large gas quantities becoming available on the market.

If this path is taken, almost USD 17bn may be invested in shale gas exploration and production by 2025, which will increase the number of wells to 1,270 (of which 1,175 wells, or almost 170 annually, will be drilled in 2019–2025). In this scenario, the year 2025 sees the

Increased foreign investment scenario		Jednostka	2012-2018	2019-2025	2012-2025
Exploration					
CAPEX	USDbn	0.7	-	0.7	
Workforce (annual average)	thousand	0.9	-	0.4	
Exploration wells converted to producing wells					
Number of wells		65	175	240	
CAPEX	USDbn	0.8	2	2.8	
Workforce (annual average)	thousand	1	3.2	2.1	
New producing wells					
Number of wells		30	1,000	1,030	
CAPEX	USDbn	0.4	12.9	13.4	
Workforce (annual average)	thousand	0.4	11.9	6.1	
Total CAPEX on shale gas exploration and production (shale gas investment)	USDbn	1.9	14.9	16.8	
Total workforce associated with shale gas exploration and production (shale jobs)	thousand annual average	2.2	15.1	8.6	
Shale gas output (at end of period)	m m ³	1,032	11,934	11,934	



production launch of 305 wells annually, and the volume of gas output is nearly 12bn m³. The launch of the same number of production wells in each of the subsequent years, requiring annual expenditure to the order of USD 3.5-4bn, would result in continued production growth, to over 19bn m³ of gas in 2034.

Irrespective of the selected path, the first years of development will be similar in terms of gas production volumes as the sector must reach a critical mass of knowledge, experience and assets in order to launch production on a larger scale. A considerable difference between the scenarios will begin to be visible near 2020, i.e. in seven or eight years from now. However, it is necessary to remember that the investment cycle in the shale gas sector counts in decades and the effects of such investments must not be expected overnight.

A twenty-year perspective clearly shows that a real qualitative change can be achieved only if the path assumed in the accelerated growth scenario is followed. In such a case, domestic production of unconventional gas could be three or four times higher than the production of conventional gas. In a conservative approach, assuming that the moderate growth or increased investment scenarios come to pass, all that can be expected is that shale gas output could equal the 2020-2025 levels of conventional gas production. However, neither of the two scenarios would lead to the development of a “gas economy” or improve the quality of national energy security. This is why further in this study we deal with the economic effects of the accelerated growth scenario and the conditions required for the scenario to unfold.

Micro and macro aspects of the scenarios

Given the numbers proposed in any of the three scenarios, Polish firms involved in shale gas exploration and production will be put in a win-win situation. For domestic companies, any addition to domestically produced gas means an enhanced asset base. Businesses which produce, market and consume natural gas will be able to replace imports with domestic sources of supply, benefiting from production costs being lower than costs of imports (which is the key determinant of economic viability). The absence of downward price pressures in the moderate growth and increased foreign investment scenarios will benefit domestic gas producers. Consumers, however, will be put at disadvantage.

The accelerated growth scenario changes the rules of the game. Domestic companies have to face an emergence of rivals and adapt to a wholly new reality. Improved competitiveness bears fruit in the form of enhanced ability to expand outside Poland and to gain importance on international markets. Thus, Polish companies are offered a chance to go global.

First and foremost, the accelerated growth scenario is a unique opportunity for the economy. To receive a fresh growth stimulus, Poland needs foreign investment as a source of funds for large-scale projects. Since 2008, sagging demand has been a major impediment to investment and economic growth in Europe and around the globe. Poland has been a green island on the economic rough seas, yet growth-depressing developments unfolding abroad are starting to leave an imprint on our economy as well. Gas and energy sectors are the only ones that continue to attract foreign investment. Demand for natural gas in Poland and the rest of Europe is forecast to rise, while shale gas prospects provide Poland with a golden opportunity to push forward the gas-fired power generation industry with own gas supply sources. The opportunity is there to be taken.

The key criterion in deciding where foreign direct investment (FDI) is to go has been and always will be the relative attractiveness of a given destination. As regards shale gas, what makes our country attractive is the gas resources and an enormous potential behind rising

demand for the fuel at home and all around Europe. Will Poland succeed in attracting FDI? It depends on the country alone. Key success factors include gas market deregulation plans and the time needed for their implementation, taxation of gas production, admission of foreign investors, development programmes for infrastructure and power generation that account for the domestic gas potential, and overall improvement in conditions for doing business in the country.

Capital sourced from abroad will also help spread exploration risk between domestic and foreign investors, which may be of fundamental importance should the exploration phase take longer than expected. In the U.S., a number of exploration companies often found sequences of dry wells over periods lasting for years only to hit a sweet spot that compensated them for the previously sustained losses. To survive the challenging, capital-intensive exploration phase, companies need to secure access to financing sources. Some of them succeed in doing so, others fail and go out of business. Conceivably, Polish companies that embark on intensive exploration unassisted may exhaust the available funding before production starts. The participation of competent players from abroad with access to capital will prevent domestic firms from taking on excessive risk, which would be spread among a number of foreign entities.

WHAT MAY HAPPEN IF POLAND FULLY EMBRACES THE SHALE GAS REVOLUTION

The ultimate objective of any economic policy is economic growth. While choosing economic policy instruments, one has to consider not only development scenarios for the shale gas industry *per se* but also their macroeconomic implications, as it is the latter that show politicians what can be gained and what can be lost if they take certain decisions affecting the business environment in the shale gas sector.

Polish economy, still among those “catching up” with richer countries, should use foreign investments to accelerate its growth. The best foreign investments are direct and contribute know-how to the economy, a criterion that would be met by foreign investments into the development of the shale gas sector.

From 1994, Poland was attracting substantial foreign direct investments, which peaked in 2000 at nearly USD 13bn. The economic slowdown over the following years nearly halved the FDI inflow, and in 2003 Poland received only USD 5bn. As expected, the country's accession to the EU provided fresh impetus for foreign companies to invest in Poland. In 2004-2011, FDI averaged USD 15bn a year. Economic forecasts for 2012 and the following years indicate a sharp economic downturn around the world and recession in the Eurozone. As a result, the Polish economy will slow down too, and if history is to repeat itself, a steep decline in foreign direct investment will be among factors contributing to the downturn.

An industry with a potential to attract direct private foreign investors despite the turbulent times is shale gas exploration and production, and in the following years – also the power sector based on domestically produced gas. Gas production and low-emission power generation in Europe enjoy healthy and steady demand. The only impediment to their further development is limited availability of financing on the continent. The situation may be alleviated by an inflow of private capital from abroad, interested in shale gas exploration and production in Europe on the back of very attractive gas prices.

Poland may become the magnet for such investments and, as demonstrated by estimates in the accelerated growth scenario, may receive major foreign contributions in the form of FDI in the shale gas and power sectors. Apart from the expenditure on shale gas exploration and production totalling PLN 17bn in 2012-2025 (USD 1.5bn a year), the scenario highlights the need for investments in the power sector and gas transmission infrastructure, requiring twice as much funds (USD 35bn in total, USD 3bn a year). In 2012-2025, necessary outlays on gas-related investments under the accelerated growth scenario would be USD 50bn, i.e. on average USD 4.5bn a year, over 80% of which would come from foreign investors.

Analysis of macroeconomic effects by scenario

The expected macroeconomic effects of shale gas production would include chiefly a surge in investments and employment within the E&P sector itself and in cooperating industries, followed by multiplier effects related to rising incomes of businesses and households. Domestically produced gas has a positive effect on a country's balance of trade, as financial flows linked to purchases of gas from abroad (imports) are re-oriented to the domestic market (production). Under the scenarios featuring high FDI, there are increased outbound transfers of capital income (profits) to foreign countries, having a reverse effect on the balance of payments. If foreign firms pursue their own business strategies based on Polish gas, their profits will be reinvested, increasing the FDI inflow into Poland. Its own gas reserves would strengthen Poland's economic vitality, leading to a long-term GDP growth and larger stream of tax revenue from business activity (VAT, PIT, CIT). Higher employment rates and newly created jobs would stimulate the labour markets, especially in areas where gas would be produced, which are currently among the poorest in the EU. An improvement in employee qualifications could be expected across the whole education spectrum. In areas of gas production, employment growth and work activation would be the most pronounced and jobless rates would fall, driving up the incomes of households and municipalities, and improving the quality of people's lives.

How the scale of these effects is measured under the analysed scenarios depends on the adopted macroeconomic model. In the presented study, an aggregate model was used, which allows to track all the effects with equal accuracy.

The accelerated growth scenario, leading to the emergence of a large and entirely new sector, produces a number of changes in various areas of the economy as well as far-reaching effects in the entire country.

Economic effects of moderate growth scenario vs. no-shale-gas scenario				
	Unit	2012-2018	2019-2025	2012-2025
<i>Nominal values</i>		<i>Total for period</i>		
GDP	USDbn	4.7	35.2	39.9
Private consumption	USDbn	2.3	14.2	16.5
Public consumption	USDbn	0.8	6	6.8
Investment spending	USDbn	5	29.9	34.9
shale gas sector	USDbn	2	6.1	8.1
other sectors	USDbn	3.1	23.8	26.9
<i>Real growth</i>		<i>Annual average</i>		
GDP	pp	0.03	0.09	0.06
Private consumption	pp	0.02	0.05	0.04
Public consumption	pp	0.03	0.09	0.06
Investment spending	pp	0.14	0.2	0.17
		<i>Annual average</i>		
Workforce	thousands	11.8	53.9	32.8
Employment in shale gas sector	thousands	2.2	6.1	4.1
Employment in other sectors	thousands	9.6	47.8	28.7
Unemployment rate	pp	- 0.09	- 0.35	- 0.22
New jobs created in subperiods	thousands	21	53	74
Disposable income - real growth	pp	0.02	0.05	0.03
<i>Nominal values</i>		<i>Total for period</i>		
Sources of finance	USDbn	5	29.9	34.9
FDI	USDbn	0.6	2.1	2.7
shale gas sector	USDbn	0.6	2.1	2.7
other sectors	USDbn	0	0	0
Domestic+foreign (financial)	USDbn	4.4	27.8	32.2
shale gas sector	USDbn	1.3	4	5.3
other sectors	USDbn	3.1	23.8	26.9
<i>Nominal values</i>		<i>Total for period</i>		
Tax revenue	USDbn	0.7	5.4	6.1
PIT+other	USDbn	0.2	0.9	1
Indirect tax revenues less subsidies	USDbn	0.6	4.3	4.9
CIT from shale gas sector	USDbn	-	0.2	0.2
Multiples				
Investments in shale gas sector		1.6	3.9	3.3
Employment in shale gas sector		4.4	7.9	6.9

Note: The table presents differences relative to the base-case scenario. The assumptions for shale gas exploration and production reflect both nominal values and differences relative to the base-case scenario, which assumes that no shale gas industry will develop.

Source: CASE estimates

Economic effects of increased foreign investment scenario vs. no-shale-gas scenario				
	Unit	2012-2018	2019-2025	2012-2025
<i>Nominal values</i>		<i>Total for period</i>		
GDP	USDbn	4.7	43	47.6
Private consumption	USDbn	2.3	18	20.3
Public consumption	USDbn	0.8	7.3	8.1
Investment spending	USDbn	5	40.2	45.2
shale gas sector	USDbn	2	9.4	11.3
other sectors	USDbn	3.1	30.8	33.9
<i>Real growth</i>		<i>Annual average</i>		
GDP	pp	0.03	0.13	0.08
Private consumption	pp	0.02	0.08	0.05
Public consumption	pp	0.03	0.12	0.08
Investment spending	pp	0.14	0.36	0.25
		<i>Annual average</i>		
Workforce	thousands	11.8	67.4	39.6
Employment in shale gas sector	thousands	2.2	9.1	5.7
Employment in other sectors	thousands	9.6	58.2	33.9
Unemployment rate	pp	- 0.09	- 0.44	- 0.26
New jobs created in subperiods	thousands	21	82	103
Disposable income - real growth	pp	0.02	0.07	0.05
<i>Nominal values</i>		<i>Total for period</i>		
Sources of finance	USDbn	5	40.2	45.2
FDI	USDbn	0.6	4.3	5
shale gas sector	USDbn	0.6	4.3	5
other sectors	USDbn	0	0	0
Domestic+foreign (financial)	USDbn	4.4	35.9	40.3
shale gas sector	USDbn	1.3	5.1	6.4
other sectors	USDbn	3.1	30.8	33.9
<i>Nominal values</i>		<i>Total for period</i>		
Tax revenue	USDbn	0.7	6.6	7.4
PIT+other	USDbn	0.2	1.1	1.3
Indirect tax revenues less subsidies	USDbn	0.6	5.2	5.8
CIT from shale gas sector	USDbn	-	0.3	0.3
Multiples				
Investments in shale gas sector		1.6	3.3	3
Employment in shale gas sector		4.4	6.4	6

Note: The table presents differences relative to the base-case scenario. The assumptions for shale gas exploration and production reflect both nominal values and differences relative to the base-case scenario, which assumes that no shale gas industry will develop.

Source: CASE estimates

Economic effects of accelerated growth scenario vs. no-shale-gas scenario				
	Unit	2012-2018	2019-2025	2012-2025
<i>Nominal values</i>		<i>Total for period</i>		
GDP	USDbn	4.8	174.8	179.6
Private consumption	USDbn	2.3	58.5	60.8
Public consumption	USDbn	0.8	29.9	30.7
Investment spending	USDbn	5.2	155.8	161
shale gas sector	USDbn	2	15.2	17.1
power sector	USDbn	0.2	35.5	35.7
other sectors	USDbn	3.1	105.1	108.2
<i>Real growth</i>		<i>Annual average</i>		
GDP	pp	0.03	0.81	0.42
Private consumption	pp	0.02	0.48	0.25
Public consumption	pp	0.03	0.81	0.42
Investment spending	pp	0.16	2.58	1.36
		<i>Annual average</i>		
Workforce	thousands	12	218.6	115.3
Employment in shale gas sector	thousands	2.2	15.1	8.6
Employment in other sectors	thousands	9.8	203.5	106.7
Unemployment rate	pp	-0.09	-1.55	-0.82
New jobs created in subperiods	thousands	22	488	510
Disposable income - real growth	pp	0.02	0.48	0.25
<i>Nominal values</i>		<i>Total for period</i>		
Sources of finance	USDbn	5.2	155.8	161
FDI	USDbn	0.7	23.4	24.2
shale gas sector	USDbn	0.7	23.4	24.2
other sectors	USDbn	0	-	-
Domestic+foreign (financial)	USDbn	4.5	132.4	136.8
shale gas sector	USDbn	1.4	27.3	28.7
other sectors	USDbn	3.1	105.1	108.2
<i>Nominal values</i>		<i>Total for period</i>		
Tax revenue	USDbn	0.7	25.6	26.3
PIT+other	USDbn	0.2	4.1	4.3
Indirect tax revenues less subsidies	USDbn	0.6	21.3	21.9
CIT from shale gas sector	USDbn	-	0.2	0.2
Multiples				
Investments in shale gas sector		1.4	2.1	2
Employment in shale gas sector		4.5	13.5	12.3

Note: The table presents differences relative to the base-case scenario. The assumptions for shale gas exploration and production reflect both nominal values and differences relative to the base-case scenario, which assumes that no shale gas industry will develop.

Source: CASE estimates

FOUR KEY AREAS OF ECONOMY TO BE AFFECTED BY THE SHALE GAS SECTOR

In the detailed presentation of the macroeconomic effects further on in this report, we focus on four key areas of the economy to be affected by the shale gas sector, especially under the accelerated growth scenario. First and foremost, gas production and related direct and indirect investments create new jobs. Approximately 510 thousand people may find employment. Another development opportunity is related to instilling the spirit of innovation in Poland. The country may find itself among three largest markets to have launched commercial production of shale gas. A lot remains yet to be discovered in the field of technology and organisation of the industry and those ready to pick up the tab will develop the sector in the following years. The state budget will gain a new tax revenue stream,

which might total nearly PLN 90bn (USD 26bn) in the first decade of the sector development. Investments will stimulate economic growth and in 2012-2025 add on average 0.4 pp a year to the country's GDP, while in 2019-2025, after the launch of production – as much as 0.8 pp.

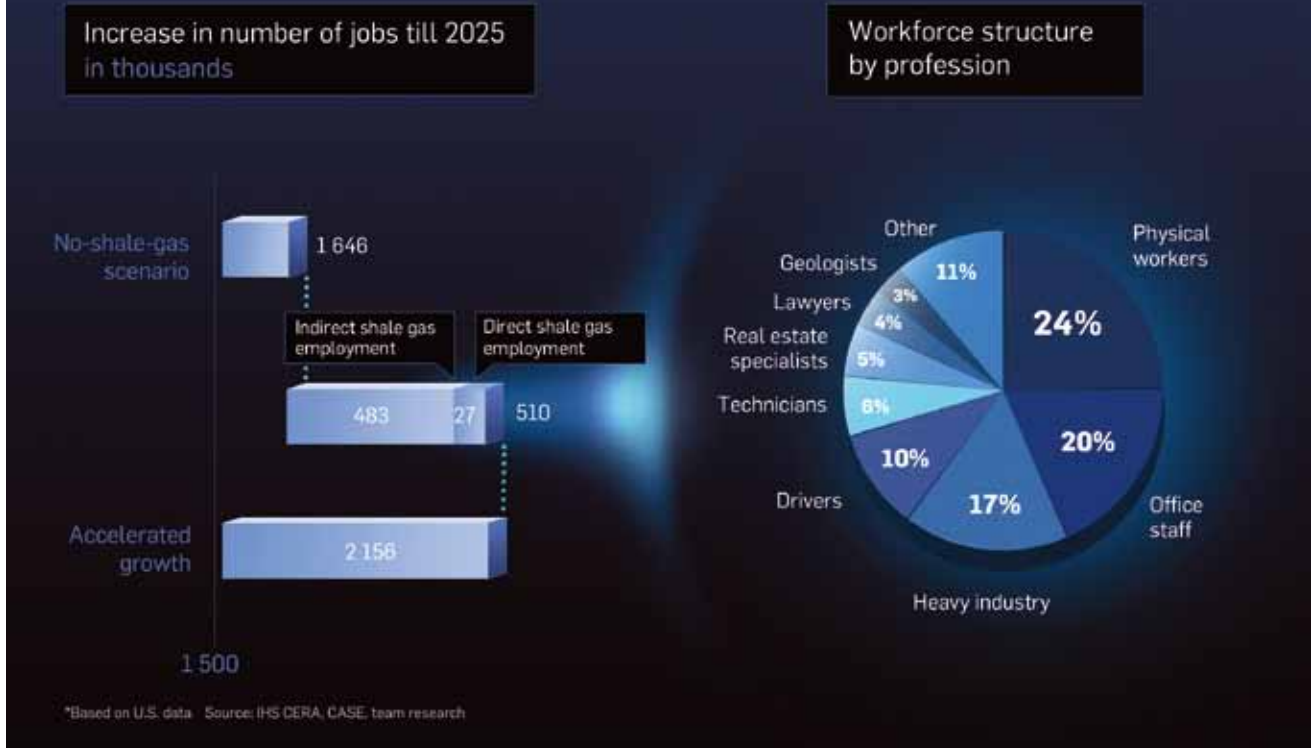
New Central Industrial District

The creation of 510 thousand new jobs will be a big boost for the economy. The accelerated growth scenario assumes that in 2025 the unemployment rate will decline by 3 pp vs. the no-shale-gas scenario.

Low-skilled labour (in whose case the required skills can be learned relatively quickly) represent one-fourth of all the employed in the new sector. However, white collars may account for little less, that is one-fifth of the sector



The shale gas industry may create 510 thousand jobs



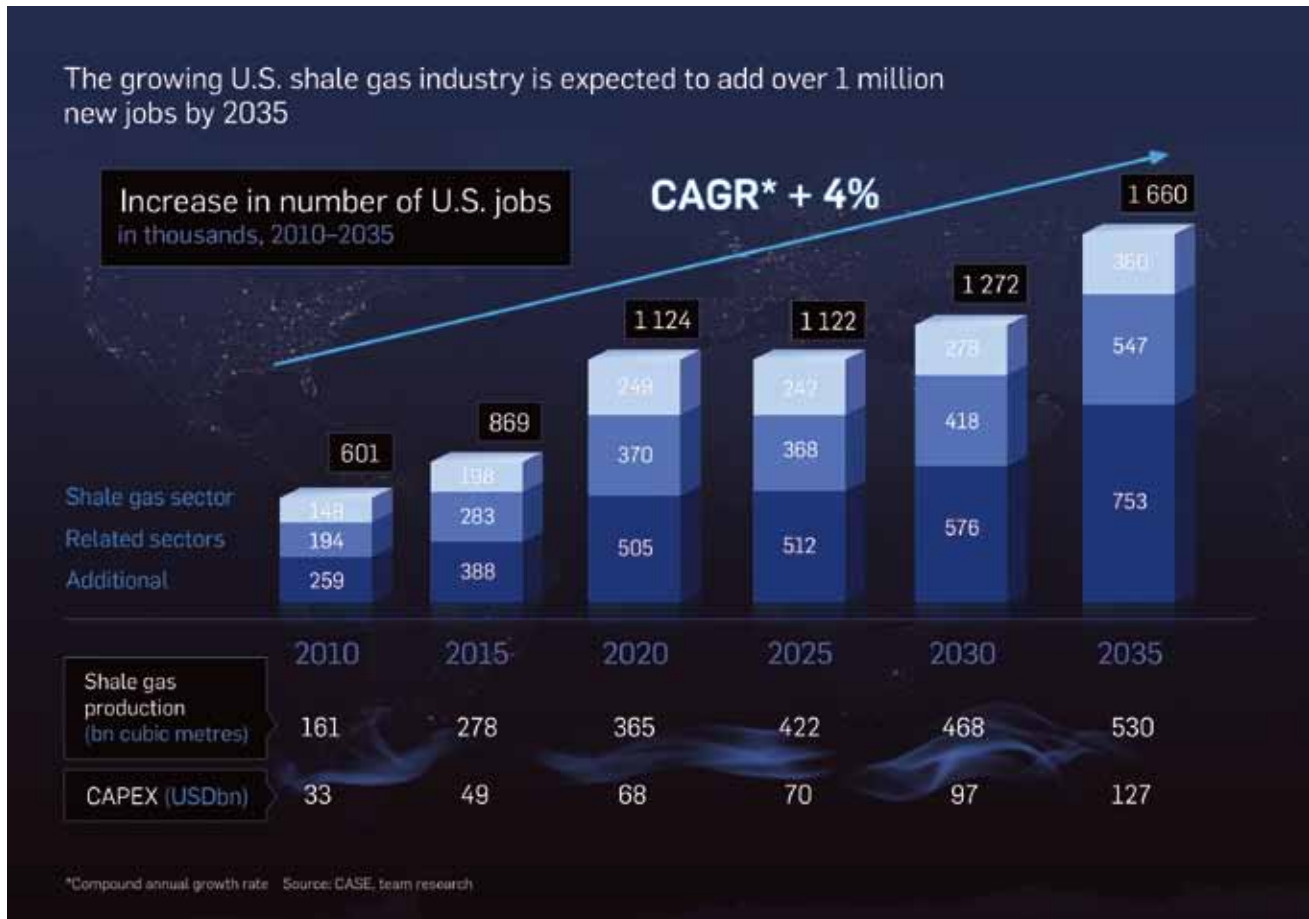
workforce. The development of the shale gas industry generates demand for various jobs, thus allowing people with different work experience and education to find employment. What is more, only approximately 27 thousand of the newly created jobs will be available in the shale gas sector *per se*, i.e. directly related to gas production. The remaining 483 thousand jobs will appear outside the extractive industry, provided by business partners and springing up in the economy at large on the back of growing incomes.

What the Central Industrial District was for the Second Republic of Poland in the 1930s, shale gas may be for Poland today. Investment efforts focused then and will concentrate now on poorly developed regions. However, before WWII, the objective behind choosing the location was, apart from equalising the standard of living within

the country, to ensure the safety of industrial facilities at a time of a foreign invasion. Now, the nature itself, having endowed the regions with mineral resources, tapped them to become the major beneficiaries of the change.

An upward trend in employment following the increase in shale production has been confirmed by analyses of the U.S. market. Currently, the U.S. shale production industry, broadly understood, supports over 600 thousand jobs. In the 25-year horizon, that figure may soar to above 1.6m, with a CAGR of 4%.

Production of gas from shale requires extensive economic resources to be employed in multiple ways. Below we present a few examples illustrating the complexity of the task to develop the new sector of the economy. Those



specific examples will serve to demonstrate the essence of the multiplier effect, which will mean creation of a relatively large number of jobs connected with shale gas production.

The depth of a single borehole can be compared to 17 buildings equal in height to Warsaw’s Palace of Culture and Science stacked on one another – it may be as much as 4 kilometres. Drilling a borehole takes up to two months, however, this time may be significantly shortened as more experience is gathered during initial drillings. The sole task of making a thorough examination of Poland’s resources would require at least a hundred of such boreholes. If the accelerated growth scenario is pursued, the number of production wells coming on stream annually may reach 300.

Boreholes are serviced by trucks, which need to make from 700 to 1,400 runs per borehole. Add to this construction of the required temporary transport infrastructure and operation of vehicles. Hence, development of the upstream shale gas industry would bring benefits for the transport sector as well.

Assuming the depth of 4 kilometres, each borehole requires from 400 to 600 tonnes of steel piping. Accordingly, 300 boreholes annually, as provided for in the accelerated growth scenario, would mean consumption of additional 120-180 thousand tonnes of piping. For the manufacturers, this translates into a 40-60% growth of the domestic market.

Impacts of shale gas production on employment and economic activity across sectors

FACTS ABOUT SHALE GAS WELLS:

<p>Depth 17 times the height of the Palace of Culture and Science</p>		<ul style="list-style-type: none"> The depth of a single well may come up to 4 kilometres or 17 times the height of the Palace of Culture and Science in Warsaw A well is drilled for about 60 days, giving employment to anything between 20 and 60 people on a 24/7 basis
<p>700-1400 truck cycles per well</p>		<ul style="list-style-type: none"> Works at a well construction site require 700 truck cycles, creating additional jobs (truck driving, vehicle operation, construction of roads and the related infrastructure)
<p>40-60% rise in pipe consumption</p>		<ul style="list-style-type: none"> A total of 300 thousand tonnes of steel pipes were used in Poland in 2011. A single 4 kilometres-deep well requires 400-600 tonnes of steel piping, which means that 300 wells a year consume 120-180 thousand tonnes of the material, driving up total consumption 40-60% and providing a unique opportunity for domestic producers
<p>10,000 litres of diesel oil used for power generators daywork</p>		<ul style="list-style-type: none"> Power generators used to support work on a well consume, depending on the stage of work, up to 10,000 litres of diesel oil per day, driving extra demand for products refined domestically
<p>Increase in industrial production</p>		<ul style="list-style-type: none"> Development of shale gas deposits will bolster demand for pumps, power generators, tanks, compressors and other equipment, increasing industrial production and/or promoting creation of new manufacturers

Source: team research

Hydraulic fracturing, in turn, will result in an increased demand for diesel oil. The fracturing operations involve the use of high-performance pumps, which are powered by diesel generators. Daily fuel consumption per borehole may be up to 10 thousand litres of diesel oil. This would mean higher demand for the Polish refineries' products – 10 thousand litres corresponds to an additional mileage of 160-170 thousand kilometres for a standard diesel-engine car.

The shale gas production sector stimulates growth of the domestic industrial output. The required equipment such as pumps, generators or tanks may well be produced by Polish companies. Therefore, it would bring about improved industrial production and higher employment in Poland. The higher employment and income levels would in turn boost demand for consumer products and services.

On the lookout for a Steve Jobs of Polish shale


Production of gas from unconventional sources is currently an area comparable in terms of the invention and innovation rates to the Internet start-ups from Silicone Valley. This is a natural ground for cooperation between businesses and academic centres, the development of which has been discussed in Poland for a long time.

Shale gas business involves highly advanced technology. Let us quote the comparison used by Schlumberger, a leader in shale gas production: the precision of work performed currently underground by top drilling companies can be likened to dropping a plumb-line from the top of the Empire State Building (381 metres – over two times more than the height of Warsaw's Palace of

The shale gas industry will help create an innovative sector in the Polish economy with strong export potential


Acquisition of new competencies with strong exports potential

R&D centres in the Shale Valley




- Establishment of Polish competence centres to develop unconventional resources extraction technologies for customers from all around the world
- Increased productivity of hydraulic fracturing

Geological modelling



- Development of geological modelling competencies

Industrial development



- Stimulation of manufacturing of components and finished products for the drilling and related industries (compressors, pumps, power generators)

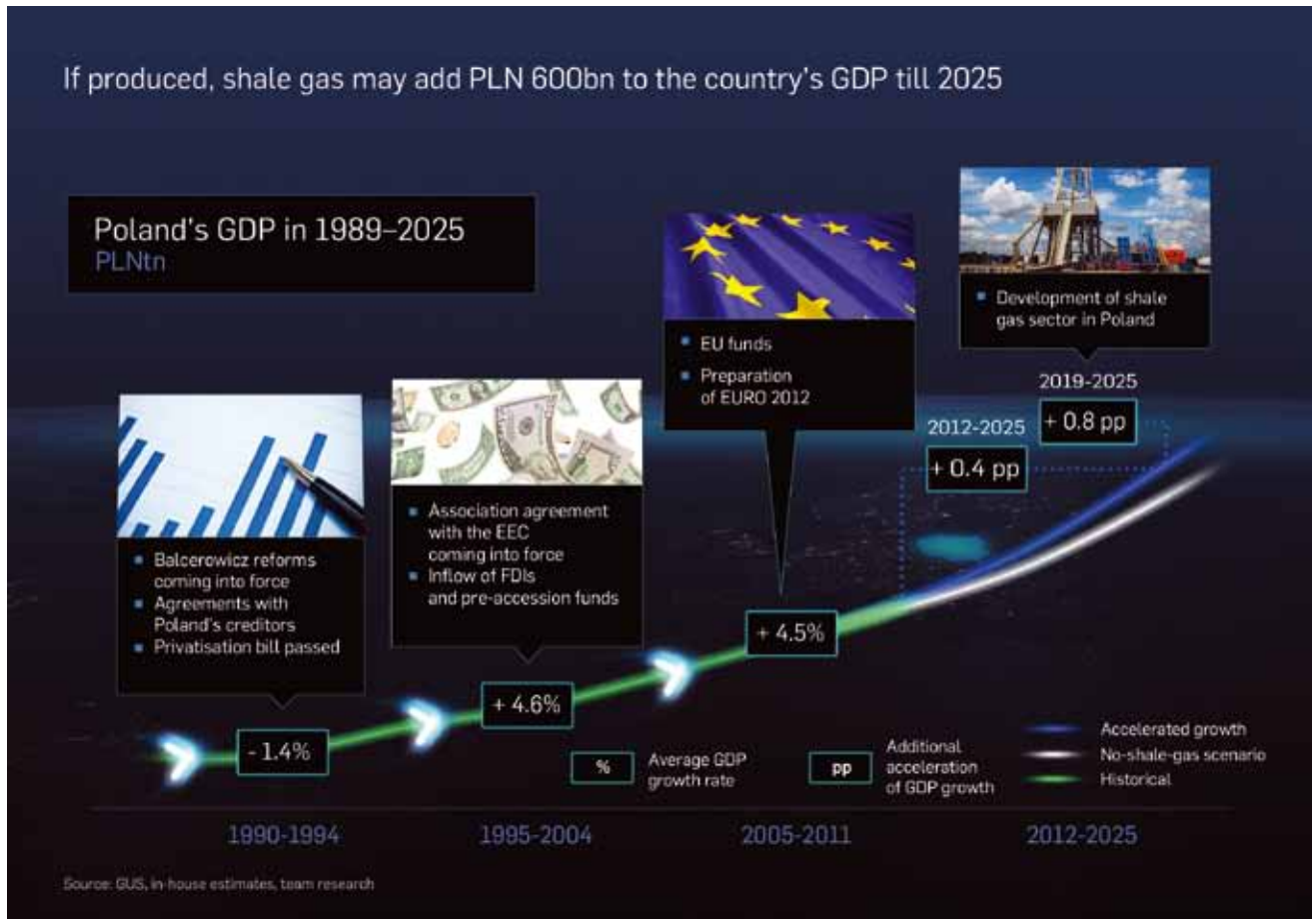
Source: team research

Culture and Science), bending it at a right angle just above the ground and then guiding it through the rear and front windscreens of every car parked in the nearby streets.

If in the case of the accelerated growth scenario the industry embraces foreign investors, Poland will see an inflow of know-how brought by the leading global players as well as application of imported world class technologies. Poles will be given an opportunity to get to know state-of-the-art solutions and take part in their creative advancement. In fact, in a few areas, after some time, Poles may begin to set global standards. Cases in point are geological modelling, development and production of subassemblies for the drilling industry, or expounding the theory of mechanics of crack (fracture) propagation in shales to improve productivity of hydraulic fracturing.

Along with the development of new technologies, there may also come opportunities to export them to other countries which make a start in the shale gas industry later than Poland. The R&D expenditure in 2011 is estimated at USD 1.3tn (according to PPP). The research capabilities built on the basis of the extractive sector need not be limited to one field – on the contrary, they may be applied more broadly.

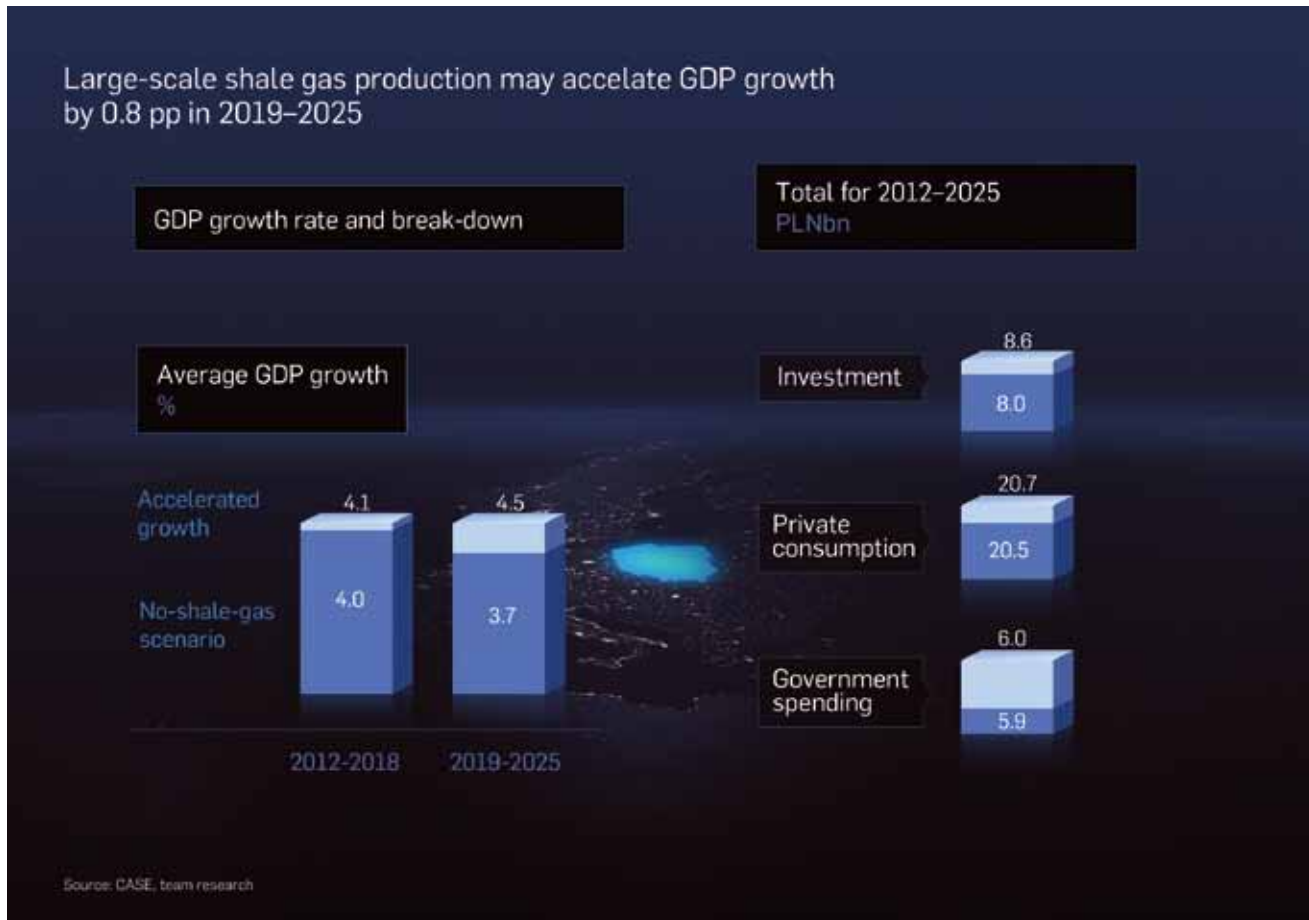
The extractive sector has a substantial R&D market, with the largest service companies spending hundreds of millions of dollars on research annually. For example, the research spending of Schlumberger in 2011 was approximately USD 3bn, while each of Baker Hughes and Halliburton spent over USD 400m. So the stakes are high. Shale gas sector development in Poland would support continued high economic growth rate over the next



two decades, which are likely to be much different from the past 20 years. Since the onset of the economic transformation in Poland, economic growth has been driven to a smaller or larger extent by external or structural forces rather than strictly business-related factors.

All those developments required significant effort and intense work. However, the decisive factor in the acceleration of economic growth was the available foreign funding – FDI and EU funds. While in both cases the decision makers responsible for the transfer of capital to Poland were based abroad, domestic factors had a substantial role in the inflow of capital. In the case of FDI, they determined Poland's attractiveness to investors, and in the case of structural funds – our ability to absorb them.

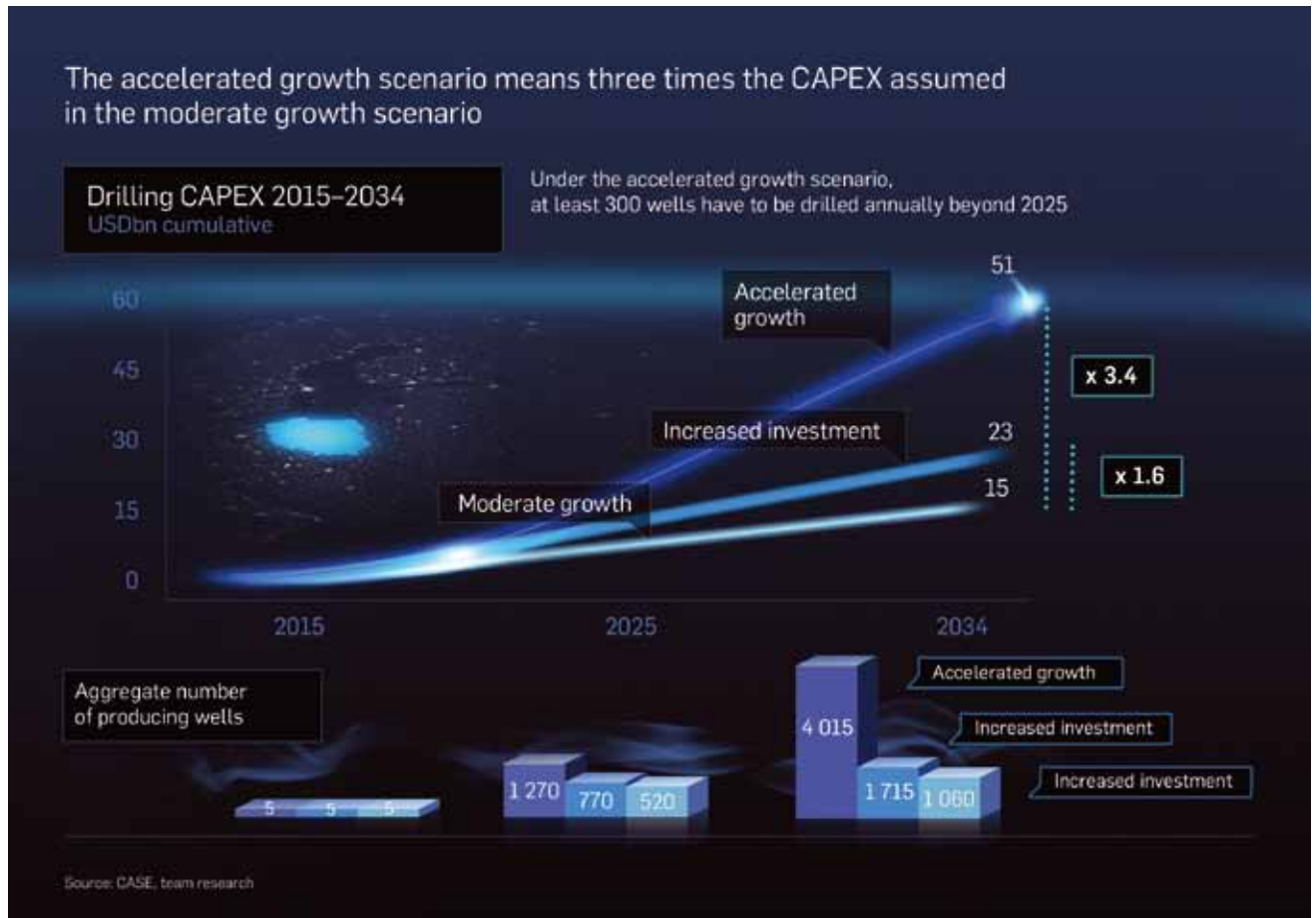
Whether we will be able to turn the opportunity offered by the presence of shale gas deposits into a viable business project and to implement that project successfully depends chiefly on the steps taken domestically to enhance the investment attractiveness of the Polish shale gas industry in comparison with alternative locations for foreign investments (in the neighbouring countries shale gas deposits may be present in Ukraine and Russia, while the country with indisputably the largest potential in the global perspective is China). This is a crucial problem, which needs to be addressed when estimating the long-term impact of shale gas on Poland. To note, what is at stake is an additional 0.4 pp of GDP growth in 2012-2025, including 0.8 pp in 2019-2020.



Economic growth will be spurred by investment

The principal driving engine for the GDP growth until 2025, related to shale gas production, will be investments. Development of the shale gas sector as a green-field venture requires substantial expenditure on the sector's assets: drilling platforms, pumps, transmission equipment, appropriate trucks, or infrastructure for the workforce performing the drilling work, such as accommodation trailers. When considering the accelerated growth scenario one must bear in mind also investments to be made in the power industry to redirect a large portion of the demand for energy resources to the resources produced domestically. In that scenario, transformations in the power sector in response to the increased domestic gas production

account for approximately two-thirds of the investment growth. It should be noted again that the accelerated growth scenario provides for investments of USD 17bn (USD 1.5bn annually) in exploration for and production of shale gas in 2012–2025, with another USD 35bn (USD 3bn annually) to be spent on investments in the power sector and gas transmission infrastructure. In aggregate, the indispensable gas-related investments amount to nearly USD 50bn, or USD 4.5bn annually, of which over 80% will be financed by foreign investors. To compare, based on the National Bank of Poland's data, in 2004–2011 FDI inflow to Poland was almost EUR 90bn (USD 120bn), or approximately USD 15bn annually, representing nearly one-fifth (18%) of gross capital expenditure on property, plant and equipment made in that period.

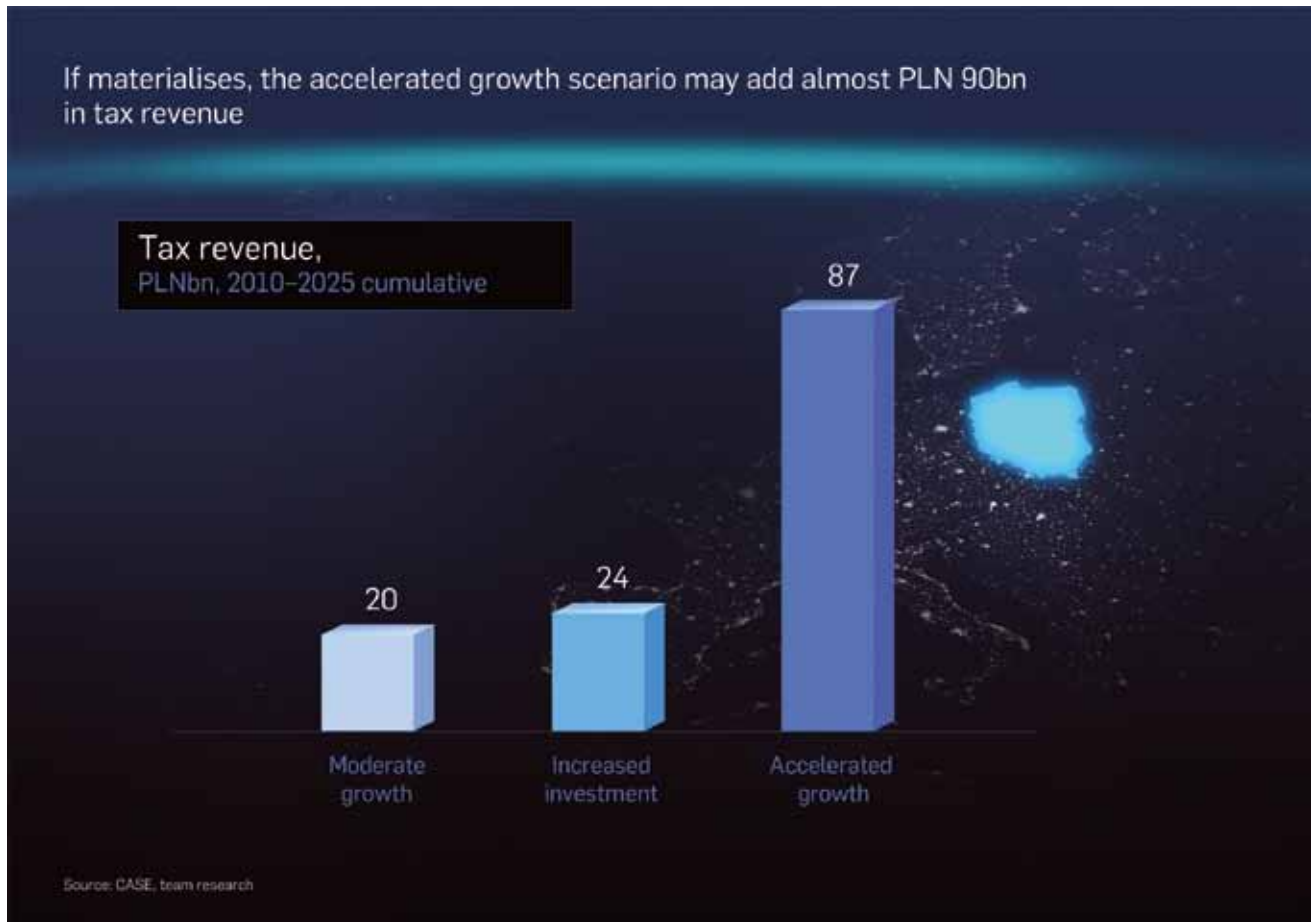


Under the accelerated growth scenario, the volume of investments is over three times higher than in the case of the moderate growth scenario. In a longer-term horizon, beyond 2025 at least 300 boreholes will need to be drilled annually. Accordingly, assuming the most optimistic scenario for the shale gas production sector in Poland, over 4,000 boreholes may be expected to have been drilled by 2034, relative to approximately 1,000 boreholes in the case of the moderate growth scenario. With this scale of investment, expenditure on drilling may exceed USD 50bn over 19 years. This will require a mobilisation of capital in the economy – USD 2.7bn annually on average. For the sake of comparison, the “contract of the century”, under which Poland purchased 48 F-16 aircraft, was valued at USD 3.5bn, and the contract for the delivery of 690 *Rosomak* wheeled armoured vehicles

at approximately USD 1.5bn. The average annual value of investments required to implement the most intensive scenario is therefore comparable with the value of the largest defence contracts executed by Poland after 1989. The contracts were always much commented on, and perceived as landmark moments for Poland and its economy. Now we are facing a business venture of a similar value, to be carried out continually, year after year, over the next two decades.

A chance to step up economic growth

The great challenge to be faced by Poland’s economy obviously comes with correspondingly large potential benefits. Over the past 20 years, Poland tackled many demanding tasks, which made a lasting change by

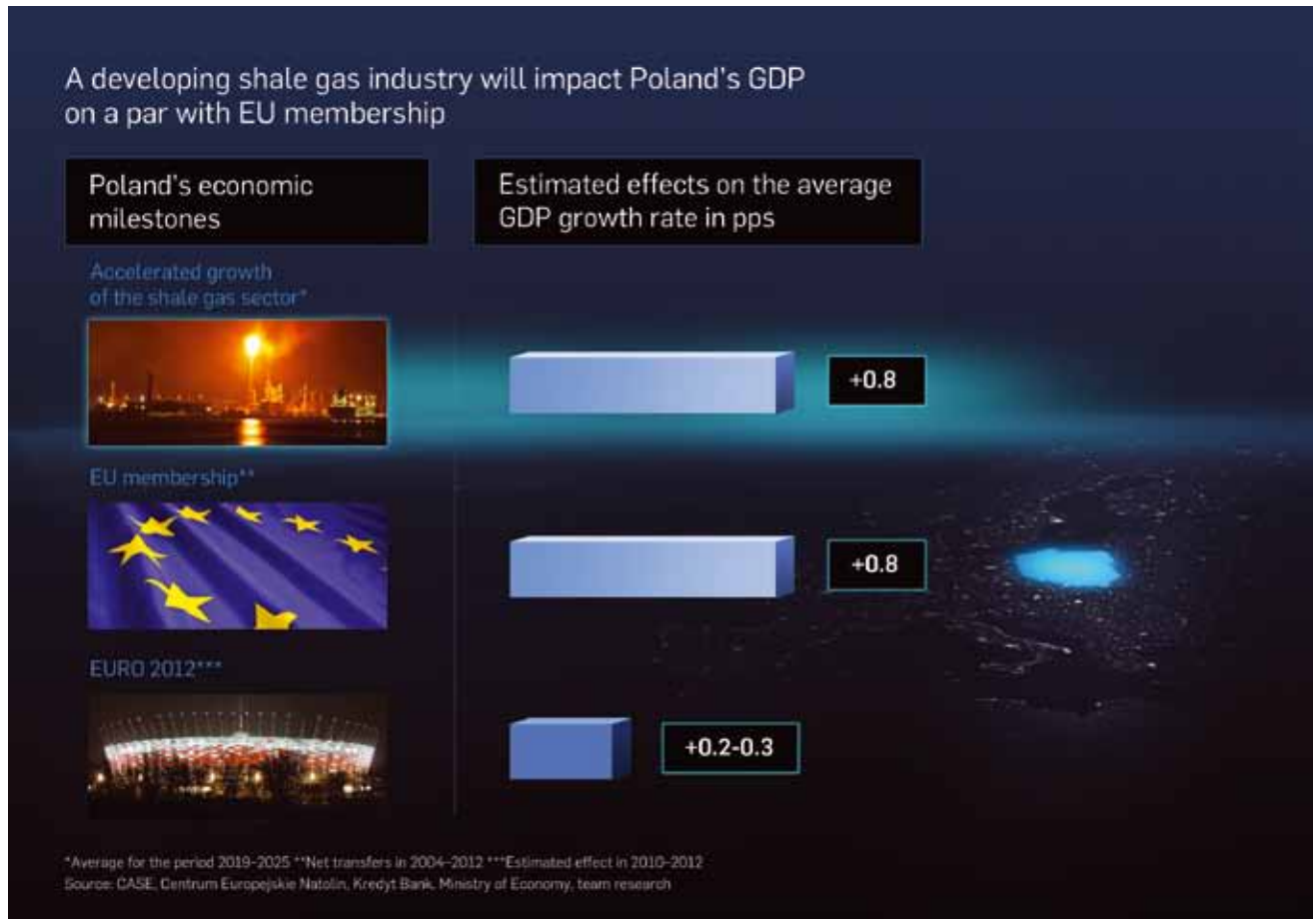


improving the country's image in a manner that had earlier seemed improbable. However, it was three of them that indisputably set Poland on a new trajectory in the most visible way: the inflow of large direct foreign investment, accession to the European Union, and co-hosting of the EURO 2012 Football Championship. Embarking on shale gas production has a potential to become another landmark event of a similar scale and may define the development path for Poland's economy for at least twenty years.

The emergence of such a large new industry in the Polish economy would result in higher tax revenue. It may be expected that if the sector develops quickly, the cumulative additional tax revenue, generated largely by an increase in economic activity (VAT, PIT

and CIT), would reach approximately PLN 90bn by 2025, which is nearly three times more than the 2011 revenue from corporate income tax (PLN 31.7bn). For comparison, the annual spending on higher education and healthcare services in 2011 was ca. PLN 12bn and PLN 7.5bn, respectively. Therefore, already in the initial phase of shale gas production in Poland, during the first 10–15 years, the amount of related tax revenue will be significant relative to Poland's national budget.

According to a 2003 report by Centrum Europejskie Natolin, the EU membership was to contribute approximately 0.8 pp to Poland's GDP annually. The scale of changes driven by the EU membership can be seen, for instance, in the modernisation of the road infrastructure. In 2003, just before the country's accession to the EU,



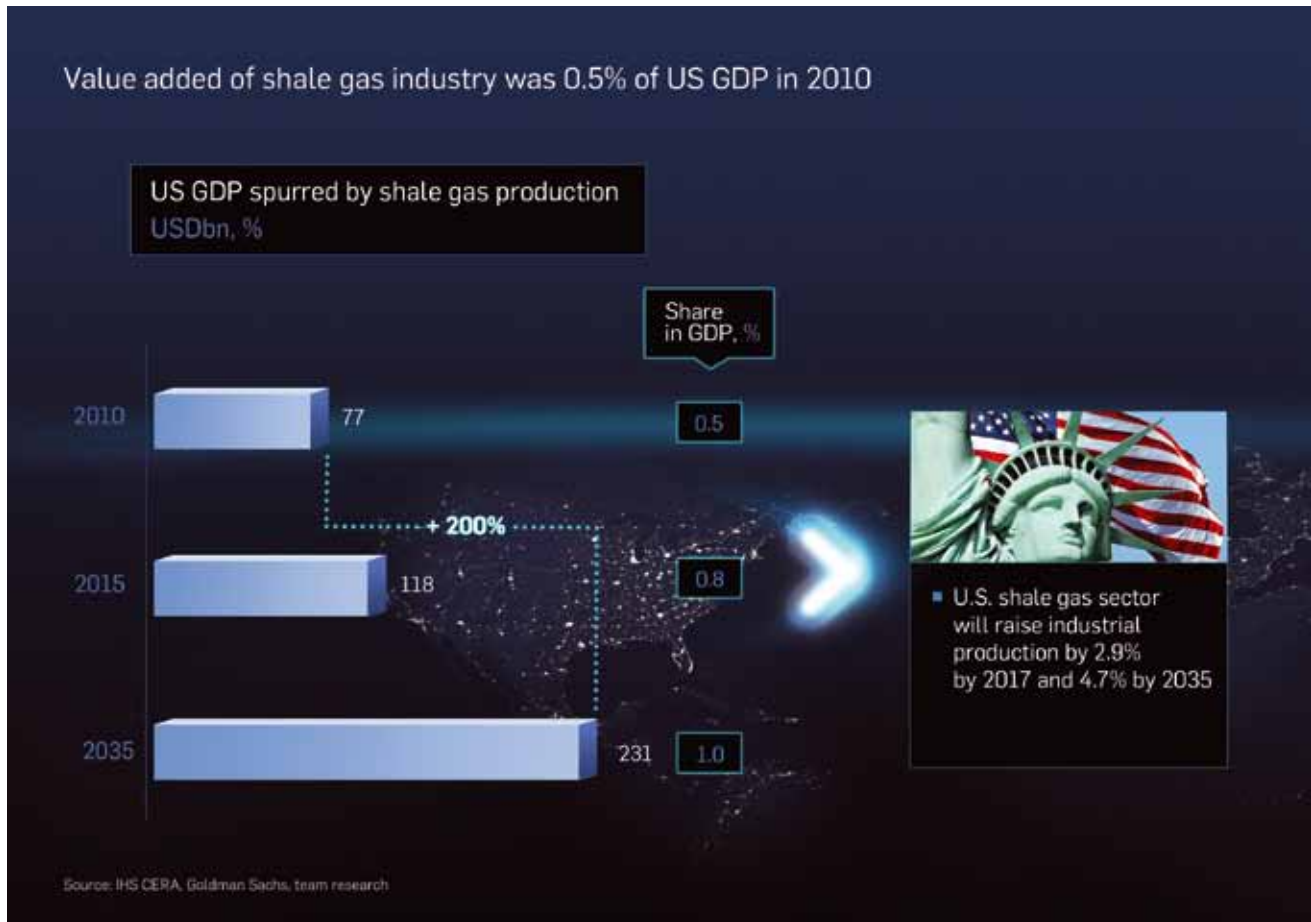
there were approximately 640 kilometres of motorways and expressways in Poland. In 2011, it was already over 1,500 kilometres. Also, in 2003 170 kilometres of such roads were under construction, compared with over 1,300 kilometres in 2011.

The EURO 2012 Football Championship contributed approximately 0.2-0.3 pp to the GDP over the past few years. It should also bring effects, although still difficult to measure, related to the expected increase in the number of tourists visiting Poland and a generally improved perception of our country abroad.

Development of the shale gas industry may contribute 0.4 pp annually to Poland's GDP in 2012-2025, and then 0.8 pp in 2019-2025.

HOW IT IS DONE IN AMERICA, OR THE IMPACT OF UNCONVENTIONAL GAS PRODUCTION ON THE U.S. ECONOMY

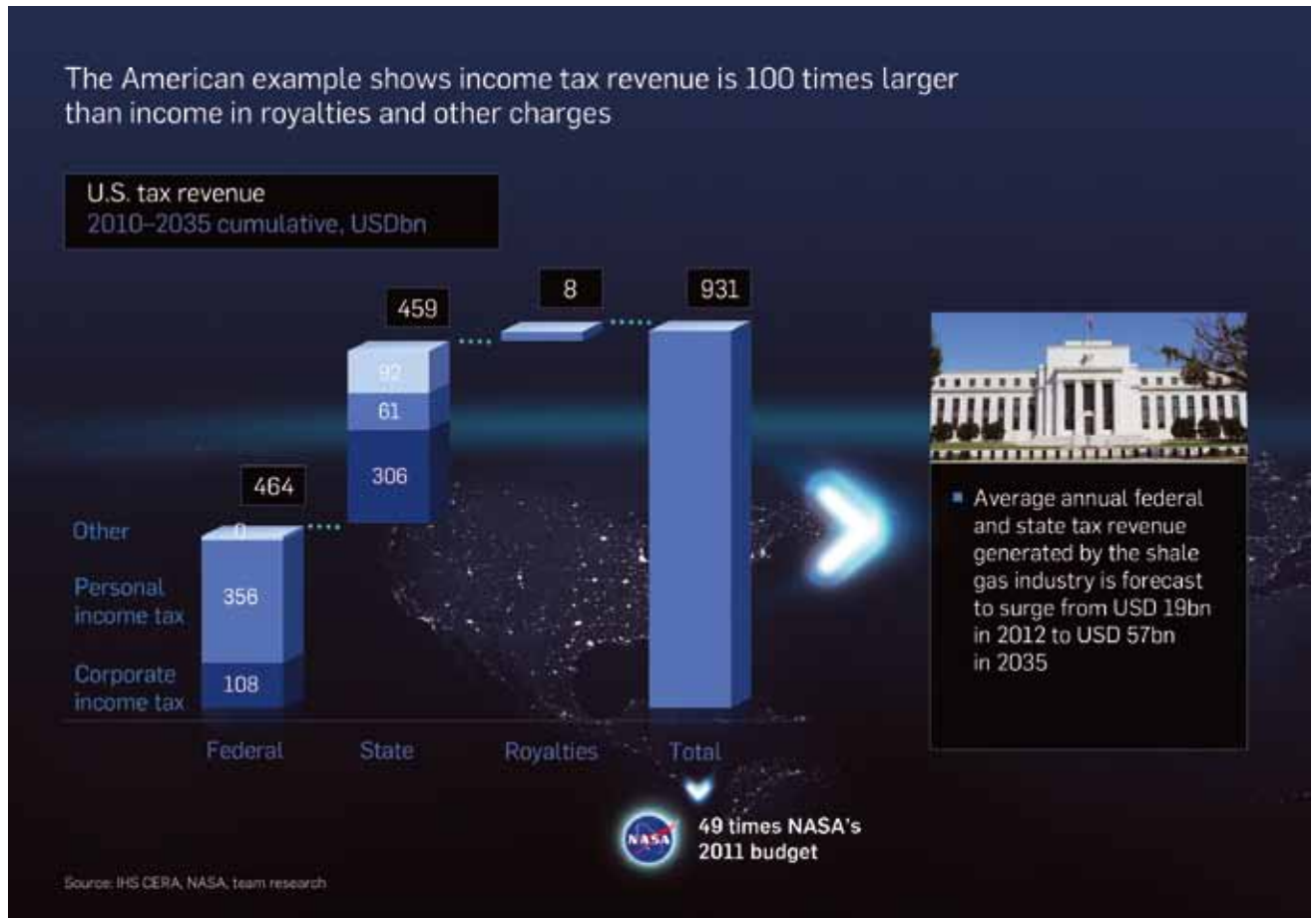
To date, the U.S. is the only country where shale gas has been produced on a commercial basis. The development and implementation of a commercially viable production technology proved to be a strong impulse for the growth of this largest economy in the world. In 2010, production of gas from shale accounted for 0.5 pp of the U.S. GDP, that is USD 77bn. In 25 years it is expected to be 1 pp, with the rest of the economy continuing on the growth path.



Needless to say, there are marked differences between Poland and the United States. The U.S. fed shale gas to the existing gas system. In Poland, most of its gas comes from imports. It is treated as fuel which, being expensive, should be used only for “special” purposes. Therefore, no system capable of absorbing very large amounts of gas has been developed. The need to build such a system (gas energy sector, extension of the system for gas distribution to households) is another factor supporting the thesis that the development of the gas production sector will yield additional economic growth at a level which, in percentage terms, will be at least comparable to that seen in the U.S., as the size of Poland’s economy is relatively smaller in relation to the required investments.

Naturally, in the United States much larger amounts are at stake as the U.S. shale gas production sector is much greater. The area of Polish shale deposits presumed to hold commercially attractive quantities of gas is similar the area of the Bakken formation, one of a dozen or so gas fields in the United States. The cumulative tax revenue related to shale gas production in the United States in 2010–2035 is estimated at over USD 930bn, nearly 50 times more than the annual budget of NASA. President Obama’s 2008 economic stimulus package was worth USD 862bn.

What is worth pointing out is that the structure of U.S. tax revenue primarily comprises, at both the federal and state levels, personal and corporate income tax rather



than royalties. Relative to total tax revenue, royalties may be considered marginal as they represent less than 1% of the total figure for 2010-2035.

As can be seen in the United States, the structure of tax revenue may be altered by various means. Changing the amount of royalties is only one of a number of possible solutions. In a holistic approach, analyses of optimum forms of the tax system should take into account not only the revenue from gas production, but also revenue related to all business activities which would not have been launched had it not been for the development of the shale gas sector; this includes power utilities operating gas-fired plants, as well as chemical plants using gas in production processes.

Importantly, domestic gas production helps make business profitable in sectors with high labour intensity. This is crucial in view of the continuing rise in labour costs in Poland, which adversely affects the country's competitive advantage and, in consequence, prompts job creation in regions with lower labour costs.

THE ACCELERATED GROWTH SCENARIO – SUCCESS FACTORS

Above all, the success of the most ambitious growth scenario for the shale gas production sector in Poland requires simultaneous and coordinated work in the following four areas: changes in the mining and geological law, adjustment of tax regulations to the new



conditions, demand planning for the extracted gas, and development of the necessary gas infrastructure. The rapid growth of the Polish shale gas industry should be facilitated by active support from foreign entities, in particular from the U.S. and Canada, with relevant experience in the shale gas business. All these elements must be well managed and coordinated.

A business-friendly state

In order to develop the shale gas industry, we need an appropriate legal framework tailored to the industry's nature. Today, the most pressing regulatory issues include:

- Inconsistent use of concepts and notions by the legislator and their inconsistent interpretation which depends on the nature of a legal transaction at hand;

- Legal loopholes, or omissions that result in matters of key importance to shale gas start-ups being left out (no regulations are available that would adequately reflect the economic role and features of shale gas production sites);
- Unclear and ambiguous definitions and interpretations of terms and expressions that are of fundamental importance to the sector.

To ensure the sector's harmonious development, it must be treated differently from traditional extractive operations. In this case, there is no need to build huge mines using methods perfected for decades. Instead, shale gas operations are very dynamic, since they require extensive test drilling and the ability to flexibly respond to changing circumstances.

The existing legal environment may be a serious impediment in the investigation and completion of shale gas reservoirs. For instance, investors are required to specify the target depth range of the planned drilling work already when applying for relevant environmental permits. If the ensuing exploration work reveals presence of a productive reservoir several dozen metres deeper than originally assumed, then the application procedure has to be repeated, which may protract the process by several months up to over a year. In the case of shale gas occurring in relatively thin deposits, it is usually impossible to precisely determine the drilling depth in advance.

It is obvious that legislation ought to regulate business activity, rather than hamper business ventures that make economic sense. However, even with the best of intentions, lawmakers are not able to foresee all the possible scenarios for how the situation related to shale gas production may develop, or to prevent all potential abuses. A policy of controlled trust for entrepreneurs is a prerequisite. This is particularly important in the shale gas industry, which is still developing and continually generating new solutions. Therefore, entrepreneurs should not be constrained by overly stringent regulations. Such a prior protection is bound to be less effective than having operators take responsibility for their own actions, whilst severely and consistently punishing any errors on their part.

The key functions of a fiscal system are to ensure appropriate distribution of profits, efficient exploitation of resources and effective cost recovery mechanisms, while fostering investment. There are many fiscal systems in the world, with some jurisdictions relying even on several different systems simultaneously. Conditions suitable for certain countries may not be suitable for others. An optimally designed tax system should balance the state's share in profits with the geological risk of E&P projects. As there are no two identical reservoirs, there should not be two identical tax systems.

Heavy fiscal burdens should only be imposed if the geological risk is negligible. Excessive burdens cripple private sector's demand for production projects,

eventually depriving the state of tax revenues. The risks inherent in exploration work strongly discourage operators from incurring exploration costs, unless of course prospective future profits are high enough (and conversely – they are a strong incentive in the case of solutions rendering E&P projects more profitable). From the strategic viewpoint, the thing of paramount importance is to maximise the state's discounted future revenues from exploitation of mineral resources. Excessive taxes have the effect of ultimately eroding the profitability of the state's resources, even if initially they may deliver a large revenue stream.

It should be clearly stated that an irresponsible fiscal policy may in consequence deprive the state of revenues from its natural resources. Taxes and levies unrelated to profits (e.g. bonuses and royalties) make for a regressive tax system (i.e. one that imposes a greater tax burden on lower profits). States sacrifice potential gains in the upstream segment by introducing more regressive fiscal regimes. The more heavily a state budget depends on oil and gas (e.g. in Russia, where oil is the source of some 60% of state revenues), the more inclined it is to introduce a regressive regime.

Tax legislation is a major determinant of business decisions, as evidenced by the so-called international tax planning. Businesses tend to work out effective structures to minimise their tax burden. Tax management involves the use of jurisdictions where income taxes are low or non-existent, and also takes advantage of relevant provisions of double tax treaties. Governments must remember that when designing a fiscal system. The heavier the “tax sword”, the more robust shields will businesses try to design to safeguard their interests. In extreme cases, they may give up production altogether, but the biggest loser of such a scenario would be the state itself. After all, unexploited minerals are worthless. An entrepreneur may relocate its business to a friendlier jurisdiction, whereas the state is tied to its natural resources.

CONCLUSIONS

I. Shale gas headlines have reinvigorated public debate in Poland, and in a constructive way, with no “us versus them” mentality reborn or long-standing divisions reinforced. **The unparalleled opportunity of potential non-intermediated access to an energy source has bridged gaps in public discussions**¹. However, while the topic is being widely debated, there remains vast uncertainty as to what amount of gas is actually trapped in shales and whether it may be recovered. The uncertainty is not going away any time soon as the potential of shale rocks may be reliably determined only by further drilling. Before this study was released, as few as 20 or so wells had been drilled. Only a few of them involved horizontal drilling and hydraulic fracturing, which, after all, is the only method – assuming that sufficient number of wells have been drilled (a minimum that would permit reassessment of Poland’s shale gas potential is 100 wells) – to confirm commercial viability of development.

II. The unavailability of hard facts **about shale gas deposits kindles heated debates around various outdated estimates that fail to inspire new ideas and have little commercial value**. Obviously, businesses will rely on own drilling data and the parameters of economic policy when making relevant decisions.

III. It is, indeed, possible to measure the effects of the nascent shale gas industry. Importantly, **this can be done while setting aside the size of deposits, which is unknown and bound to remain so for some time**. The possibility is offered by simulation models of the national economy that evaluate the potential behind the growth of any given industry depending on future regulatory or business decisions. The simulation results provide an answer to the question what options are being opened, rather than what will be, if the Polish shale rocks turn out to bear sufficient quantities of gas. The answer may

vary but it will always present the future as an effect of conditional simulation depending on the parameters of economic policy, something that is entirely under our control. It is worth looking closely at the output of simulation models while waiting for fresh estimates of our shale gas potential: the mere fact of sitting on ample resources is not going to change our economic reality. Only we can change it. This present volume, compiled on the basis of the CASE report on potential impacts of shale gas production on Poland’s economy commissioned by PKN ORLEN, has addressed the above issues.

IV. The report (an unabridged text is available at www.konferencje.orklen.pl/pl/publikacje/publikacje-2012 and on the CASE website at www.gaz.case-research.eu) suggests that three basic long-term scenarios (until 2025) may be inferred about the size of shale gas production and the potential effects of its going commercial on the particular macroeconomic variables. They depend heavily on the rate of investments into the shale gas industry and the ability to finance them at the level of the whole economy. None of the scenarios **is more or less likely, considering that whether any of them will materialise or not depends on political decisions**, which are impossible to predict using any objective, scientific tools. Thus, the moderate growth scenario assumes the average annual capital expenditure of USD 0.9bn, an amount that should ensure production of up to 3.5bn m³ of gas a year. In the other two scenarios, the maximum levels of production and capital expenditure stand at 6.3bn m³ and USD 1.5bn (the increased foreign investment scenario) and 20bn m³ and USD 4bn (the accelerated growth scenario), respectively.

V. In short, the scenarios describe the following development paths for the Polish economy:

- Moderate growth scenario
 - In 2019-2025, i.e. after the initial investment phase is over and large-scale production of shale gas is

¹ In an opinion poll commissioned by PKN ORLEN and conducted by Millward Brown SMG\KRC between May 4th and May 6th 2012 on a sample of 1,000 persons, 95% of the respondents expressed a belief that shale gas will spur economic growth, while 86% indicated that shale gas will help break reliance on external suppliers and solidify Poland’s position in the world.

launched, the annual average GDP growth would be up by 0.06 pp on the no-shale-gas scenario. In 2012-2025, the growth in the number of employed would be up by 74 thousand, and the (aggregate) tax stream would expand by PLN 20bn. The annual average FDI inflow between 2012 and 2025 would grow by EUR 200m compared with the no-shale-gas scenario.

- Increased foreign investment scenario

In 2019-2025, the annual average GDP growth would be up by 0.08 pp on the no-shale-gas scenario. In 2012-2025, the growth in the number of employed would be up by 103 thousand, and the (aggregate) tax stream would expand by PLN 24bn. The annual average FDI inflow between 2012 and 2025 would grow by EUR 400m compared with the no-shale-gas scenario.

- Accelerated growth scenario

In 2019-2025, the annual average GDP growth would be up by 0.8 pp on the no-shale-gas scenario. In 2012-2025, the growth in the number of employed would be up by 510 thousand, and the (aggregate) tax stream would expand by PLN 87bn. The annual average FDI inflow between 2012 and 2025 would grow by EUR 1,700m compared with the no-shale-gas scenario.

VI. Two issues must be emphasized:

1. **Even if only the first scenario unfolds, it will usher in a profound positive change for Polish businesses involved in shale gas exploration.** For example, the average gas consumption by the ORLEN Group is approximately 1.5bn m³ a year. If the demand could be satisfied with own resources, it would considerably lower the Group's costs. That is why refining companies which are actively involved in upstream activities achieve higher market capitalisations around the world.

2. A major impetus for Poland's long-term economic growth (more than 500 thousand new jobs in different sectors of the national economy, acceleration of GDP growth by an average of 0.4 pp in 2012-2025, and by 0.8 pp in 2019-2025, generating an additional stream of

tax revenue close to PLN 90bn) can only be provided if the size of investments is significantly increased, which would involve a widespread use of foreign investment potential. **To attract reputable foreign investors, looking to base their business strategies on gas produced from Polish fields, it would be necessary – as always in the case of major foreign investors – to design programmes providing for the development of the gas and gas-based power generation sectors, taking into account foreign investors' involvement.**

VII. The report analyses potential growth paths for the Polish economy from a perspective rarely applied in the public debate. It is yet another profound and beneficial consequence of the shale gas entering the Polish dictionary. The nature of exploration and production processes requires disciplined thinking in a long-term horizon. It will take a dozen or so years before the consequences of decisions taken today are felt. This fact alone should be recognised. Owners of land plots neighbouring on areas covered by the licences, local politicians and elites, decision makers at the national level and businessmen – they are all aware of that. **The side-effect of shale gas exploration felt in Poland already today is the expansion of the planning and implementation horizon at all government levels.** It is good news for everyone, but especially for environmentalists whose attempts to discuss long-term effects of various decisions are frequently met with incomprehension. Now such discussions will become easier.

VIII. Shale gas is the first in many years a strictly Polish project – yet not in the narrow nationalistic sense, as its implementation is contingent upon the inflow of foreign capital, but as an initiative arising from Polish potential and aspirations rather than an attempt to conform to the world's expectations. After 1989, the Polish economy underwent a radical transformation, sometimes vividly described as turning fish soup into an aquarium. We accomplished that daunting task and it is our great success. However, it should be noted that the reforms

introduced in Poland mirrored Western models, which were known, tried and thus safe. We acted under the supervision of international institutions, such as the IMF, to rebuild our financial reputation. In turn, under the eye of Brussels, we modified rules governing virtually all aspects of business relations, social policy, management of public finances and a plethora of other areas – all that to join the European economic bloodstream. We brought the Polish law in compliance with *acquis communautaire*. However, shale gas production is

a different endeavour. The reserves are situated in Poland. Our plans to produce shale gas have not won a unanimous approval around the world, even in Brussels and some other countries that up to the present have been considered our steadfast political partners. In this way, **the shale gas rush has become a project allowing us to come back to the international arena under our own flag after decades of isolation and making up for lost time**. Thus it is all the more important to act in a manner that would ensure success of the project.



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