

FUTURE FUELLED
BY KNOWLEDGE

VOLUME 2

A 3D rendered white gas pipe is shown against a white background. The pipe has a knot tied around it on the left side and an orange valve with a handwheel on the right side. The valve is illuminated with a soft orange glow.

THE ERA OF GAS

*How to use this
new potential?*

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INTRODUCTION



JACEK KRAWIEC

PRESIDENT AND CHIEF
EXECUTIVE OFFICER
PKN ORLEN

Ladies and Gentlemen,

You are holding the bulletin of PKN ORLEN and demosEU-ROPA – Centre for European Strategy entitled “The era of gas. How to use this new potential?”, prepared within the “Future Fuelled by Knowledge” series intended to explore the strategic issues related to the global, European and Polish economy and a rapidly changing energy sector.

There can be little doubt that the energy sector will be facing significant changes in the not so distant future. These will result from both independent factors (a combination of dwindling oil resources and strengthened shale gas potential) as well as factors resulting from political decisions (e.g. greenhouse gas emissions reductions or bans on the construction of new nuclear power plants). These changes are symptomatic of a world whose trends are increasingly difficult to anticipate; a situation somewhat unbeknownst to the energy sector’s actors who are accustomed to operate in a usually stable and predictable sector. Although the volatility above is widespread throughout the modern day economy, what renders this situation problematic for the energy sector is the fact that most of its investment projects are not only exorbitantly costly, but usually take years before the power source comes on line and many years before the company recoups its costs. Therefore, an open and facts-based discussion on the future energy mix, with a special focus on gas (being considered as a primary fuel of the next generation energy sector), is primordial.

To cooperate on this issue of our bulletin, we have invited Professor Dieter Helm from the University of Oxford, Ryszard Malarski from the World Bank, Dr Maciej Bukowski from the Institute for Structural Research, and Dr Daria

Kulczycka and Agata Staniewską of the Polish Confederation of Private Employers “Lewiatan”.

The first article of this issue touches upon three extremely important elements of the European energy and climate policy – emissions reduction, energy security and the role of shale gas (particularly important from the Polish perspective). It is important to note that the EU’s low-carbon strategy is anachronistic, failing to address the issue of the emerging shale gas potential. Therefore, there is a need for a new European energy and climate strategy that will compensate for this lacuna and take into account new realities and embrace the new global energy market dynamic.

The second article is an attempt to define Poland’s energy mix in 2020. It is a forecast based on observed trends and the way relevant regulations in the energy sector are implemented. The author also endeavours to answer the question as to why, in spite of access to capital, the Polish energy sector does not invest in low-carbon solutions.

The third article explains why the liberalisation of the gas market in Poland is (along with energy security), a key element ensuring reliable access to cheap, high quality raw materials that will benefit the power sector, industry, and households in the years to come.

The fourth article questions Europe’s potential energy mix in the context of the nuclear catastrophe in Japan. The happenings in Japan heavily influenced the way we think about energy security and energy sources. They have also raised the question (again) of the role of coal and gas in the energy mix in this part of the world, particularly in Poland. The text underlines the importance of shale gas and the need for Poland to prepare itself for the moment when the extraction of this energy source will be possible.

I am sure that this issue of our FFbK series will encourage you to reflect seriously on future energy scenarios for Europe and for Poland.

I encourage you to read on,

Jacek Krawiec

SHALE GAS AND THE LOW CARBON TRANSITION IN EUROPE¹



DIETER HELM

PROFESSOR OF ENERGY POLICY, UNIVERSITY OF OXFORD

Europe's energy policy is based upon three main pillars: the internal energy market, the climate change package, and a set of security of supply measures (internally in respect of infrastructure and externally in respect of pipelines and energy agreements). In recent years, it is the climate change dimensions, which have been dominant.

The European approach to climate change is based upon the assumption of global leadership. Europe would, it was argued, take the lead in adopting binding targets and in creating an emissions trading scheme in the expectation that the US and then others would soon follow suit.

This leadership role was enshrined in the 2008 Climate Change Package (and the associated 2020-20-20 targets) and the creation of the EUETS. Of these, the most immediately pressing is the 2020 renewables target and the associated directive. The result has been to focus attention – and investment – overwhelmingly on a dash for wind across much of Europe for the next decade.

The dash for wind was in part motivated by the assumption that there were no alternatives in the period to 2020. Nuclear could not come on stream fast enough even for those countries minded to go down the nuclear

route, and gas was assumed to be both insecure and expensive – especially after the Russians interrupted supplies through the Ukraine in 2006 and 2009.

Facts change, and a good policy is one which takes these changes into account. The nuclear disaster in Japan is one such “fact”, and has dented nuclear ambitions beyond 2020. But more immediately, there has been a revolution in global gas markets. With the coming of shale gas, the conventional wisdom has been turned on its head: there is now so much potential gas that for policy purposes it is better to assume that supplies have the potential to exceed demand for the period right through to 2050 and indeed for the rest of the century.

European energy policy has yet to catch up with this revolution – but it will, for the implications are profound. Europe now has the option of a much cheaper short-term transition away from carbon intensive electricity generation (coal), paving the way for new technologies beyond 2020.

SHALE GAS – THE OPPORTUNITIES

Shale gas itself is not new: people have been cognisant of its existence for a very long time. What is new is the technology for accessing it at low cost. This technology is the result of applying engineering and informational technology to extraction. Horizontal drilling, developed in the oil industry, is one building block that facilitates access to diffuse reserves. Information technology enables the drill to hit the right spots through seismic mapping. Finally, once the drill finds the gas, the rocks have to be opened up, and the process of fracking has been developed to meet this challenge. Bringing these three technological developments together is what makes shale gas extraction possible.

¹ This article was commissioned by demosEUROPA – Centre for European Strategy as an independent perspective on shale gas in Europe. The article is based on a presentation given at demosEUROPA's conference on “Shale gas and the future of EU energy and climate policy”, which took place in Brussels on 6 May 2011. Copyright by demosEUROPA – Centre for European Strategy.

The fracking requires fluids and chemicals, and typically this involves water, raising environmental management questions, especially where shale gas is extracted at levels close to water tables, which supply drinking water. Extraction also causes methane leakages – in excess of those from conventional natural gas. But compared to the full coal cycle environmental impacts – methane emissions from coal mines, the energy intensive coal mining processes, the energy used in coal transportation and the supporting infrastructure, the emissions from coal stock piles, the lower thermal efficiency of coal power stations, the emissions from coal burning, the emissions from ash disposal and the electricity transmission losses (coal power stations are nearer to coal mines, whilst gas power stations are nearer to customers, as coal is costly to transport relative to gas) – shale gas is comparatively benign. Coal has other detriments too – miners' death rates, damaging miners' health, other emissions from SO_x and NO_x, and the water requirements for cooling. Shale gas is in its early days – the efficiency of water usage can be improved, water tables can be better protected and the methane issues can be addressed to reduce the damage, but not of course to completely eradicate all the risks engendered by the above. The issue here is relative damage: zero pollution is not possible for any technology.

With shale gas the issue is not whether there are shale gas deposits, it is whether these can be accessed at low cost. The earth's crust is riddled with fossil fuels – there is too much, not too little carbon available from a climate change perspective. It turns out that in the US, shale gas is so abundant and cheap that it can in places be produced at below the cost of natural gas. Reserves are sufficient already to last 100 years, and that the US has moved from being a major gas importer to even contemplating some exports. There is even some discussion of using gas for liquids. Prices have as a result collapsed, and the traditional link between gas and oil prices has broken down. Recent events in North Africa and the Middle East have, in consequence, had only a limited effect on the US gas market.

The US is not alone in this revolution, though it is way out in front, and the impact has been felt on international markets. For the US, production not only serves US needs, but it removes demand for LNG from Qatar and other producers – much of whose LNG capacity was be-

ing built with the US market in mind. Even if no shale gas is produced in Europe, US shale gas has radically changed the security and price of European supplies – provided, of course, it has the LNG capacity in place to reap the benefits – and began to limit Russia's market power.

It is however extremely unlikely that shale gas production will be restricted to the US. There are deposits across China, the Middle East, Russia and India. In Europe, the great rock structures, which yielded coal, oil and gas – extending from Poland through the North European plain under the North Sea to Britain – contain lots of shale gas (and coal-bed methane too). The issues in Europe are cost, access, land rights and environmental impacts. Inevitably, these will take time to work themselves out. Shale gas production is likely to be more post rather than pre 2020 for Europe – but the options for shale gas consumption, and gas consumption more generally have been immediately transformed.

THE IMPACT ON CLIMATE CHANGE AND CLIMATE CHANGE POLICY

At first sight, this may look like very bad news for climate change policy. Cheap abundant gas raises the relative costs of renewables and the nuclear option. The lazy assumption of some environmentalists that renewables in particular would become economic because oil production has (or is about to) peak, oil prices would go on upwards, and that gas prices would rise too because they were assumed to be linked to oil prices, turns out to be nothing more than just an assumption. Electricity – the growing choice of energy for final consumption – is decoupled from oil prices because gas and oil are decoupled.

But the negative response to the shale gas revolution is misplaced. It reflects a focus on low rather than lower carbon energy supplies in the short term. Long term, it is low carbon we need, but we also need a route to get from here to the longer term. The overwhelming recent cause of rising global emissions is coal – and its growth. Kyoto has had little impact, because it has not addressed this global trend. Anyone serious about climate change has to look to phasing out coal – or at least limiting the further growth in coal fired power stations. This is extremely urgent, and should dominate climate change debates. Whether China carries on building two large

coal fired power stations a week is vastly more important than having an abundance of windmills in the North Sea.

So if Europe wants to make a difference to global warming, and do it quickly and cheaply, the best it can do is to phase out its coal power stations. An exit from coal should be the overwhelming priority. Until recently, this was problematic, because it meant switching to insecure Russian gas. Now all that has changed: the shale gas revolution means that a more rapid coal-to-gas switch is possible – without significantly raising costs or reducing security. Indeed, since most of Europe's coal capacity is old (and often very old), the switch from coal-to-gas coincides with the replacement cycle.

From a climate change perspective, the crucial fact is that gas emits about half the emissions that coal does, and a little bit of arithmetic shows that if the current emissions from coal in Europe was halved by 2020, the overarching European target for emissions reduction would be reached with ease. Indeed, if the focus was on gas, greater emissions reductions could probably be made sooner.

An obvious objection is that once the gas capacity is built, it will be used, and Europe will need to decarbonise further. The problem then will be, having got rid of the coal, to then get rid of the gas. There are three responses to this:

- that the gas is much more flexible and hence will help to match the intermittency of renewables;
- that gas CCS is an option which Europe could pursue both for domestic and global reasons – rather than focus exclusively on coal CCS;
- the cost advantages of using gas for the transition rather than large scale offshore wind are so great that it would still be cheaper by an order of magnitude to go down the gas route and then simply close the stations down in the middle to late years of the next decade.

EUROPEAN POLICY AND GAS

Gas fits well not only with the overarching European climate change targets, but with the other pillars of European energy policy too. First, opening up the internal market for gas would speed its development. Those companies with long term take-or-pay contracts (especially with Gazprom) would not be able to stand in the way of cheaper non-oil indexed

gas. Consumers and industry would therefore benefit. On the external dimensions and security, shale gas is now an alternative to Gazprom, and that in turn means that Gazprom's ability to interrupt supplies will be greatly limited. With competitive pressure on the European counterparts, Gazprom would in time have to relax its long-term contract terms.

A second advantage is for competitiveness and the limiting of the exodus of carbon intensive industries from Europe to developing countries. Offshore wind raises European costs substantially relative to its international competitors – without making much difference to global warming. Gas maintains the level playing field. As Europe struggles to recover from the economic crisis, this is an extremely important factor.

But to achieve these benefits, European policy needs to be rebalanced. The Renewables Directive dominates everything else in the European energy market for this decade. In order for gas to quickly and cheaply provide for a transition, the first change is to revisit the Directive. Renewables have their (important) part to play: but not to the immediate exclusion of virtually everything else. It might have seemed sensible to set the 20% target in 2008, but rather than throwing the keys away for the next 12 years, it would be better to recognise that the facts have changed – and adapt policy accordingly.

What needs to be done is evolutionary rather than revolutionary. The objective is climate change, not a specific technology, or indeed a specific location. The obligations could be made tradeable, and there could be an explicit recognition that if the emission reductions are being made, these count more than undershoots of the renewable directive. The assumption should be that if the overall target is met, then the renewables share is a secondary consideration in weighing up whether member states have played their part in addressing global warming. Projects in developing countries might count too. A further step might be to include CCS projects within the target, even if these come on stream soon after 2020.

The reality is that a number of countries will miss the renewables target anyway (including almost certainly the UK), so it is a matter more of thinking about an appropriate strategy to deal with this, rather than trying to engineer a break-neck dash to build offshore wind farms.

A further change required is to focus resources on gas infrastructure. Whatever the policy framework, Europe is becoming more gas dependent. The Ukrainian crisis illustrated graphically how exposed south east Europe is because their gas networks are not fully interconnected and not all countries have extensive coastal LNG import facilities. In addition to the broader benefits from interconnection, the case for supporting infrastructure for LNG is considerable. It is with this in mind that the Commission's renewed emphasis on infrastructure is most welcome.

PRODUCTION OF SHALE GAS IN EUROPE

These measures and benefits arise independent of the production of shale gas within Europe. If Europe can exploit its considerable shale gas resources as well, the benefits of a gas transition would be correspondingly magnified.

There are several reasons why European shale gas will lag behind the USA's (and other's) developments. The resource base is not so well understood because it has not been so extensively seismically surveyed with shale gas in mind. Nevertheless, Europe's geology is well known, and there is little doubt there are potential reserves. Poland is an early focus.

To extract the shale gas in Europe requires the development of a complex regulatory regime to be developed. It is akin to the challenge when North Sea oil and gas was first discovered, but with the added complexities of land ownership, planning and water resources.

Europe's property rights are typically very different from those in the US. In the latter country, owners of the top soil typically own anything they can get access to below the surface. This is a major incentive to exploit subsurface resources. The US too has big open spaces – Europe is crowded and has diffuse land ownership. As a result, negotiations with land owners are inevitably going to be more complex, and the role of the state as an intermediary will be crucial.

As with the CCS projects, there is clearly a role for the European Commission to set out framework rules for

shale gas developments. This might also contain proposals for a European regulatory role. In part, this is inevitable since the Commission already regulates much in the water sector, with the Water Framework Directive.

THE LONGER TERM – IMMENSE TECHNOLOGY OPPORTUNITIES

Shale gas is not a silver bullet for the climate change challenge. It is however one important part of the solution. Europe's strategy to date has clearly not worked: it has had no serious impact on global warming. The leadership approach, focused on Copenhagen, has not resulted in the US coming on board, and in turn. It is obviously time for a Plan B – in a context within which there is unlikely to be any credible binding and effective international agreement for some time.

In the medium to longer term, there are a host of technologies which could make a big difference. The convergence of information technology and electricity networks to create active rather than passive systems opens up enormous possibilities on the demand side. The electrification of transport potentially signals an end to the growth of oil – indeed we may even end up leaving a lot of it in the ground. Battery advances may transform storage, especially as car batteries play their part. A host of new ideas for carbon free generation of electricity are coming out of universities and research centres around the world.

But these things take time. And time is not on our side – unless the relentless growth of emissions is stemmed in the next two decades, the warming effects may already be great enough to do enduring damage and risk destabilisation of the climate. Contrary to the current assumption in European policy, renewables in their current form are not going to make any difference to global warming in the next two decades. They will not even make much difference to “European warming”, especially if nuclear power is phased out earlier and the coal stations extend their lives to fill the gap (as in Germany).

Therefore, with Plan A clearly not going to work, the case for a new plan is overwhelming. Add in the change in “facts” and now is the time for a major rethink.

DEVELOPMENT TRENDS IN THE POLISH POWER SECTOR



**RYSZARD
MALARSKI²**

ENERGY MARKET EXPERT

“ELECTRICITY IS THE GREATEST AND MOST IMPORTANT SINGLE INGREDIENT IN THE WORLD OF TOMORROW”, SAID ONE OF THE UTILITY WORKERS IN THE NEW YORK FAIR IN 1930.

This text is an attempt to define Poland’s energy mix in 2020. It is a forecast based on observed trends and the way relevant regulations are implemented. It is a subjective assessment of possible individual decisions taken by the management boards of power generating companies. It is an attempt to follow the mode of thinking of those who take decisions whether to build new capacities or not.. I am not guided by the wishful thinking of politicians, expressed in their strategies and papers prepared as requested by the Commission. I am not governed by opinions of any academics, who present scientific evidence to prove which solutions will be the best for Poland. I am not guided by the dreams of ecologists that result from ideology or religion. I also do not stick to international commitments or EU directives accepted for implementation, as I am not assured of their stability. Therefore, although this forecast is prepared in good faith, I do not wish to elide the fact that it is written in very unstable times. From the perspective of basic economic knowledge,

which fortunately is becoming more and wider spread in Poland, we may state that investors are those companies which (a) have money or access to the latter, and (b) that are profit-driven. The first condition appears to be met. The companies’ CEOs claim that there is enough cash available in Polish and foreign power generating companies. They also have a possibility to finance their investments with borrowed funds. In addition, they can also obtain financing by means of a public offering, as most of them are listed companies. Therefore, what reasoning lies behind their reluctance to invest? The problem lies with the all elusive “profit” or indeed the very lack of it. It is therefore crucial that we examine the elements engendering the uncertainty in the “energy production” sector.

DEROGATIONS

At the end of March this year the European Commission adopted a Decision on derogation and published the guidelines in the form of a relevant Communication, but investors remained uncertain and unimpressed. However, it did give rise to discussions, negotiations and inevitable protests in Poland. It seems that our voice is barely audible in Brussels. Poles seem unable to shape the contents of regulations, protesting loudly only when the regulation is *a fait accompli*, and the entire legislative process already completed. Then we bring out the big guns (intervention by the prime minister or a petition to the tribunal) and get irritated that the treatment we receive is comparatively harsher than that experienced by other Member States. However, is it worth to stand up and fight for derogations and consequently pay less attention to other issues? The economic impact of seven years of free emission allowances allocation in the power industry (from 70% in 2013

² Consultant of the World Bank.

to 0% in 2020) for a new coal combustion plant, which can generate electricity (for 40 years) is low. Each new plant without free emission allowances, however, has to compete with plants existing before 2008. These will be granted the allowances if they invest in modernization. On the other hand, a more modern power plant will be more efficient. Moreover, by emitting less sulphur, nitrogen and dust, the plant will lower the cost of its environmental fees.

This balance, however, must seem unfavourable, since CEOs do not choose to implement investment projects. So should we help them by announcing that Poland will not apply for derogations? If this is the case, all the plants, new and old, will be on an equal footing and will get involved in investment projects without waiting for a national investment plan (no later than by 30 September 2011) and the Commission's decision on this matter (which will be given a few months later), and the income from auctions to the state budget in 2013 will be correspondingly higher. Then there is still the considerable problem of finding a way to protect consumers sensitive to high electricity prices. A part of these additional inflows to the state budget might be used to relieve some of their predicament. From a political point of view, lack of application for derogation seems hard to accept. If the application is filed however, it is still highly probable that the details will remain unsettled until mid-2012. Still, some guidelines may already be identified in both documents: transition from 70% to 0% will be more or less linear, coal fired power plants are not likely to be taken into account due to the suggestion of production structure diversification. Even so, a lot will depend on the European Commission's subjective interpretation of the above.

PRICE OF CO₂ EMISSION ALLOWANCES

The overall value of derogation is related to the price of CO₂ emission allowances. The European Commission forecasts its price based on available economic models, which simplify reality. Consulting companies often publish their own forecasts, but in general the actual value of the CO₂ emission allowances corresponds to a thesis proposed earlier (that there will be power cuts, or that the electricity prices will exceed the financial resources of consumers,

or that we will smoothly close down some Polish mines, and that we will transform the coal fired power plants first into gas fired ones which will later be replaced by wind turbines, or that we have to build nuclear power plants, because it is already profitable, etc). The Commission forecasts the price of EUR 14.5 per emission allowance within the 2010-2014 period, and EUR 20 within the 2015-2019 period (in accordance with the annex to the guidelines on derogation, fixed prices of 2008).

JP Morgan forecasts EUR 33 for 2020, and Deutsche Bank EUR 48 for the same year. Forecasts prepared by various analysts fluctuate within quite a wide range, from EUR 25 to 67. Therefore, it seems that the price is more or less as difficult to predict as currency exchange rates. It would be irresponsible to base a business plan for an investment project on such forecasts. Furthermore, the CO₂ market is not a "normal" market – its price has no impact on supply. It is rather a pseudo-market with the dominant influence of regulations, bans and orders.

The price of CO₂ emission allowances also depends on the chances to conclude a new global agreement after 2012. Under circumstances of uncertain growth, prospects in the global economy and fiscal pressure, discussions regarding a post-Kyoto agreement are, euphemistically put, not dominant within global political debates. However, EU policy remains ambitious. The European Union, ignoring the doings of other players, follows the principle of "what doesn't kill you makes you stronger". In addition, there is still no profound analysis of the climate and energy policy that would be to the benefit of individual EU countries, thus helping the latter to answer the question as to whether they can benefit from the expected technological revolution in the energy sector.

In view of the demands for higher reduction of CO₂ emissions in the EU, some economic sectors may be operating on the edge of economic existence. It seems that nobody controls the entire business environment created by the multiplying regulations under the EU climate and energy policy. Furthermore, the instruments of the climate and energy policy sometimes have contradictory targets, for instance the relationship between the basic target of CO₂

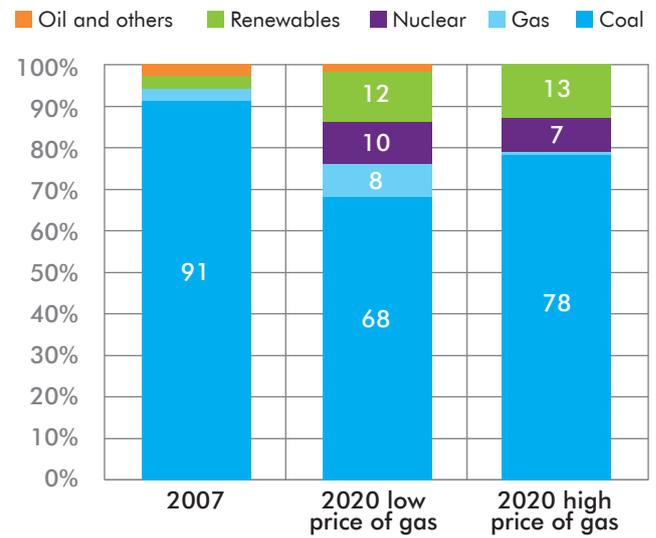
emission reduction and renewable energy promotion. As an example, professor Böhlinger, focusing his empirical research on Germany, demonstrated that renewable energy sources (RES) contribute to a drop of CO₂ emission allowances price, which consequently lead to a greater utilization of “dirty” fuels, such as lignite.

PRICES OF FUELS

The main cost component in electric power production in a conventional power plant is fuel. It accounts for 40-50% of the costs incurred by coal fired power plants and ca. 70-80% in the case of gas fired plants. In nuclear power plants, fuel cost is minimal, ranging from 15 to 25%. Since fuel price has no longer been established by fundamental factors, but by financial markets, the strong fluctuation of raw material prices has been observed on the global markets. The additional “last minute” factor is the “Springtime of Nations” of North Africa, raising the important question mark as to whether OPEC countries can provide/ increase the supply of fuels, especially crude oil. According to recent reports of KBC energy market analysts, in the future, any additional increases to World supply may only be expected to come from OPEC, as other such producers e.g. the USA and Canada are already working at full capacity. On the other hand, CERA’s reports suggest that by 2020 the USA and non-OPEC countries (including Russia and Canada) will remain the chief players in the provision of additional crude oil supplies (note: they are developing high-oil technology).

The over-liquidity of the financial markets, which is a consequence of loose monetary policy carried out by inter alia the Fed, manifested itself as a flood of speculative funds, some of which were invested in raw materials. This broke the connection between fuel prices and fundamental factors, and that in turn resulted in huge difficulties with forecasting the costs of electric power production in Poland. McKinsey & Company also demonstrates an interestingly strong correlation between electricity and gas prices in Germany, which, when combined with the correlation between Polish and German electricity prices, allow us to draw the conclusion that the strong correlation between electricity and gas prices is equally extant in Poland. We may expect

Figure 1. Optimal structure of electric power production in Poland in 2020, the World Bank’s report



Source: the World Bank, Transition to a Low-Emissions Economy in Poland, February 2011, www.worldbank.org/pl/lowemissionseconomy

that if Poland starts to generate more electricity from gas, the correlation between its electricity and gas prices will similarly increase.

Forecasting gas prices remains crucial. The World Bank’s latest report (Figure 1.) includes an attempt to optimize the electric power production structure in Poland based on the technical limitations, costs and potential of emission reductions. As can be discerned from the chart below, the cost of gas, i.e. whether it be “cheap” or “expensive”, impacts significantly on Poland’s potential energy mix. The low gas price scenario would mean its higher share within this structure.

SUPPORT FOR ENERGY FROM RENEWABLE RESOURCES

From among all the energy sectors, Renewable Energy Sources (RES) stay the furthest away from free market rules. Its source of support remains with public backing. The green certificate price is currently ca. 60 EUR/MWh. However, this price is not guaranteed and the system,

set to expire in 2015, may not be renewed. Any investment decisions in the RES sector depend directly on the subsidy scheme.

LIBERALIZATION OF ELECTRICITY PRICES

Most countries in the world subsidize energy. In 2007, the 20 largest non-OECD countries paid a total of \$310 billion of subsidies to the power production sector. This very impressive sum demonstrates the scope for change. However, it is not known how fast these changes will be taking place and to what extent they will be relevant to Poland. One of the signals of upcoming changes is the planned reform of the electricity wholesale market whose concept is to be announced in the spring of 2012. What is important to keep in mind, is the fact that the price of electricity is the primary component in the assessment of a project's profitability.

OTHER UNCERTAINTIES

Obviously, the abovementioned factors are just a few elements of the puzzle, which power companies' CEOs are trying to solve. There is a host of minor, more detailed issues, which may have a significant impact on investment decisions. One of them is how the state makes use of the revenues from emission allowances auctions. What and to what extent will the State be supportive by the way of subsidies, if these revenues are not absorbed by current consumption needs in what is yet another difficult budgetary year?

To clarify the issue of investment risks, I have attempted to present them in the table below (Table 1.). The more asterisks, the higher the risk related to the investment in the power sector.

The table above merely serves for the purpose of demonstration and orientation. It is not my intention to assess each of the risks precisely. I do not treat the sum of asterisks as a synthetic measure of the risk. This due to the following:

- the selection of 7 risk categories was made on subjective basis and does not exhaust the entire catalogue of specific risks related to individual investment projects;
- all the elements are considered on an equal basis; I have not introduced any system of weights or probability distribution, and limiting the number of asterisks to 3 may be equally imprecise;
- there might be a correlation between some of the components, e.g. between the fuel price and the price of CO₂ emission allowance;
- in the 4 selected groups there is a number of subcategories which might have totally different characteristics than a given fuel's average.

The impact of technological progress can in no way be predicted. However, we can assume that the progress will undoubtedly surprise us. Many engineering or economic analyses assume that technological progress is expected to come just like "manna from heaven". A statistically significant correlation was observed between economic growth and decreasing energy consumption

Table 1. Investor's risk matrix

TYPE OF PLANT	COAL	GAS	NUCLEAR	RENEWABLES
scale of investment and financing	**	*	***	*
fuel price	*	***	*	*
emission allowance price	***	**	*	*
fuel supply stability	*	***	**	*
stability of regulations	***	***	***	***
grid stability	*	*	**	***
public consent	*	*	***	**
Total risk	12	14	15	12

Source: Own study

per unit of GDP. There is also the so-called rebound effect. This occurs when power consumption increases as more cost-efficient technologies are applied. It looks like Heisenberg's uncertainty principle is of use here. The principle that shows interconnections between the phenomenon and its observer. Do energy-saving bulbs "feel" how little electric power they use and consequently shine much longer?

A few general fundamental conclusions that can be derived from this table seem quite obvious:

- investment aimed at increasing electric power production capacity in Poland is a complex issue;
- investor's final decision will depend on interactions between the company, the state and society;
- decisions on the future of the energy sector, though important and gladly discussed and considered at a political level, depend on several factors completely independent of the politician's remit e.g. fuel prices;
- none of the technologies has an absolute advantage over others in all aspects. For instance, the renewable energy seems very attractive, but it loses in the "grid stability" category. The latter is essential, as any disruption to the energy supply is economically costly, so it is hard to imagine that investors and regulatory bodies in general will focus on the selection and promotion of new investments only in renewable resources.

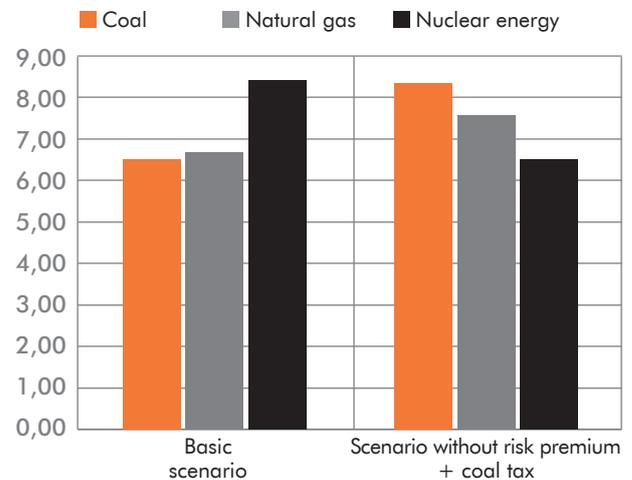
So let us analyze a few categories presented in the 'risks matrix', whilst focusing on those which were not discussed earlier. Despite the existing public opinion polls, I disregard the validity of the public consent argument, as it is strongly dependent on the way the question is formulated in the poll, as well as the context and time in which the survey is conducted.

SCALE OF INVESTMENT AND FINANCING

This category encompasses the factors related to the investment type: capital expenses (CAPEX) and operating expenses (OPEX), complicated construction of large facilities, necessity to implement new regulations (e.g. in the case of nuclear power plants), time frame of the construction, its financing, operation and others. A good index to compare available options is the one called Levelized

Electricity Generation Cost, which based on a definition provided by the OECD, is the quotient of total expenses incurred during the investment project's life and the total amount of generated energy, taking into account the costs of emission allowances purchase (Figure 2.).

Figure 2. Levelized Electricity Generation Cost (€/kWh)



Source: Andrzej Guła, *Finansowe aspekty wprowadzenia energetyki jądrowej w Polsce* [Financial Aspects of Employing Nuclear Power in Poland], Warsaw 2010

STABILITY OF SUPPLIES (ENERGY SECURITY)

The factors considered under this category are as follow: (a) dependence on import, especially from one supplier, (b) lack or presence of supplies diversification, (c) available resources in one's one country. We know that Poland has large resources of coal, and that recent shale gas fever has gripped the nation. The issues that can be taken into account here include availability of the necessary technology closely related to the applied fuel. So far in Poland, "clean coal" may only be found in laboratories; Poland has no nuclear technology, and renewable energy technologies are mainly imported (maybe except for biomass fired boilers).

STABILITY OF REGULATIONS

Unfortunately, at the moment we can only talk about high instability (related to the prices of emission allowances,

as mentioned above). The common energy market is only starting to take shape. Currently, smart grids are being heavily promoted in the EU. Pursuant to the communication of the European Commission of November 2010, employment of intelligent grids may decrease the primary energy consumption in the EU by 9% till 2020, and an average household could also reduce its electric power consumption by 9%. At the same time it is not clear who will finance the necessary capital expenses. Leaving aside the issues related to personal data protection, it is worth mentioning that the smart grids need energy to function, just like other existing IT networks. For instance, experts estimate that in a few years time, the operation of computer networks in the USA will need an amount of electric power that equals Australia's total electric consumption.

Also instable is the availability of financial incentives that support various new technologies, e.g. CCS, from the EU budget or local budgets. The green certificates system, which contributed to the significant growth of the RES share in the electric power generation structure over the last 2-3 years, particularly within the biomass combustion field, was established to be in force until 2015. It is a well-known fact, that the regulatory bodies plan to amend the act on RES. However, it is not known what changes there will be and when they will become effective. The third phase of ETS, which comes into force in 2013 (though there are still unsolved details such as derogations and benchmarks), will not improve this atmosphere of uncertainty.

GRID STABILITY

This problem refers in particular to renewable technologies – due to their scattering and supply uncertainty, as well as nuclear technologies – due to their large power accumulation. Management of electric power supplies is substantially hindered when electricity production is dependent on weather conditions. On one hand, the literature quotes the number of 20% as a critical RES share in the electricity production structure. On the other hand, scattered sources applied up to this level have a beneficial influence on the grid operation through the reduction of grid losses. Investments in the power grid infra-

structure are necessary, but it still remains unclear where to invest, as it depends on the selection of electric power generation sources. For example, the nuclear power plants require high voltage networks, whereas scattered low voltage grids are needed for renewable resources.

POSSIBLE DEVELOPMENT TRENDS IN THE ELECTRIC POWER PRODUCTION SECTOR

In December 2009 there were 112 utility power plants and combined heat and power plants in service in Poland with installed capacity of 35.8 MW, including four 500 MW turbine units, sixteen 360 MW units, sixty 200 MW units and nineteen 120 MW condensing turbine units. This number includes 16 gas turbines with a total capacity of 547 MW.

By 2020, an increase in final energy consumption as well as in electric power consumption is expected in Poland, which will require increased generating capacities within the power industry. The literature and available expert reports suggest that the increase in real GDP will also lead to energy consumption growth which is still lower than the GDP increase (due to the economy's energy efficiency improvements). Assuming that the Polish economy will grow by ca. 3-4% for the next 10 years, and the energy consumption growth will be by ca. 1-2% slower, in the baseline scenario we can expect an increase in the final energy consumption of ca. 2% a year. This means that before this decade is out, GDP growth in Poland will require increasing the capacity of the power generation sector. One of the annexes to the Energy Policy of Poland until 2030 projects the power generation growth from 36.3 GW in 2010 to 44.5 GW in 2020, so the expected rise is 23%, which corresponds to an increase of 2.1% per year for the next 10 years.

Further in this article I will try to analyse considerations regarding the fuel structure in the Polish power industry, paying particular attention to the fuel that will be needed for the expected 8GW of net capacity to be developed over the next 10 years. Of course it may be even more in gross terms. For example, McKinsey assumes that only rehabilitation of the existing assets requires the construction of 13-18 GW capacity until 2020:

- within 2011-2015 – 1.2 GW per year;
- within 2016-2020 – 1.5 GW per year, assuming there is no possibility of import.

The future is not brought about by politicians' and experts' forecasts, but rather by market decision-making (at least to the extent that this market exists in Poland). To a lesser extent, this future is equally brought about by politicking as well as obligations resulting from the climate change package and Industrial Emissions Directive (IED). The possibilities of creating/ raising the capital for new investment projects are also important, and these are large amounts of ca. PLN 100 billion. According to McKinsey, four major power generating companies in Poland may take a loan until 2020 which will amount to as much as ca. PLN 40-55 billion and within this period generate ca. PLN 65 billion of cash for investments. This should cover the demand for investment funding in this sector. Power generating companies show relatively low debt levels, and banks will gladly lend money to companies that occupy this sector.

However, when comparing the current and potential debt to the companies' true value, one realises that the situation is less clear than previously believed. Indeed, the possibility of collecting the appropriate amount of capital from the market is not so straightforward. The analysis of individual projects shows that power companies want to finance more or less two thirds of the project from their own pocket, with only the other third lent. Therefore, what will they start to build and when? Even the largest state-owned companies operate (in accordance with the government's directions) in a purely commercial way. The "national" policy does not exist even in the supervisory board's mission, the threat of black outs, even if real, does not scare the CEOs. If there is a shortage of power and a profit-making opportunity, they will quickly construct a power-plant of some type or other. However, they see little incentive to do so right now. If they build coal capacities now, it is not clear what might happen to them under the climate package. If they build gas fired facilities now, the gas generated electricity will be more expensive than electric power produced by coal, so who will buy it? Most likely this situation will not change until 2020, with some minor changes in the pro-

duction structure. Maybe a new gas fired power plant will be constructed, some smaller coal boilers will be converted to biomass, more wind turbine rotors will be spinning on the horizon, but no profound changes should be expected until 2020.

COAL FIRED POWER PLANTS

In 2020, coal fired power plants will remain the main energy supplier. As long as CO₂ emission allowances cost naught and the current lack of support for renewable energy remains sedately low, then coal power will remain the most attractive energy investment, due to its comparatively minimalistic price tag as well as the fact that investing in coal power plants remains (and probably so for the foreseeable future) cost-effectively the most profitable option. However, due to the climate policy requirements, the departure from coal will start, and coal mines seem to "sense" this trend. Most mines consider production reduction. "Kompania Węglowa", the largest mining company in Europe that embraces 15 (which is the half of) Polish coal mines plans to reduce its production from 41 to 34 million tonnes per year before 2015. The output will also drop in Katowicki Holding Węglowy and Jastrzębska Spółka Węglowa. Only "Bogdanka" in Lublin – the only listed mine – thanks to the plant extension worth PLN 1.5 billion plans to double the production to 11 million tons per year by 2014.

These spectacular decisions, however exist, only on paper. The company RWE backed out from the construction of the coal fired unit in Poland in favour of a gas fired power plant. Katowicki Holding Węglowy planned to build a 800 MW power plant based on its closed mine Niwka-Modrzejów, but their negotiations with the partner from the power sector were abandoned. So the only projects recently implemented in Poland are: 460 MW power unit in Łagisza Power Plant, 464 MW unit in Pątnów Power Plant and 858 MW unit in Bełchatów Power Plant. Undoubtedly, in the case of high CO₂ prices the value of the power companies focused on coal will be subject to a dramatic drop. The investment phase of the coal fired power plant takes a minimum of 6-7 years. Therefore, only those investment decisions that will be taken before 2013 will have an influence on our

emissions in 2020. It is highly unlikely that these decisions will be taken in the next two years. So maybe we should turn to CCS?

The famous trial CCS facility in Bełchatów may increase the cost of electricity production by even 60%. It can surely be asserted that it is not the solution for now, especially because the probable CCS installation cost means doubling the costs of new power unit construction and contributes to costs significant reduction of its capacity. We may suppose so, as there is still no experience, both in technological and financial terms of a system of this type being built on a suitably large scale. The project in Bełchatów is permanently unprofitable, so it will require EU subsidies. The only motivation to build such facilities could be an exceptionally high price of CO₂ emission, and even then there are still other good technologies that are ahead of CCS, such as energy efficiency, cogeneration, onshore wind energy, small hydro power plants.

GAS FIRED POWER PLANTS

Gas sources are burdened with price uncertainty and political risks, manifested by the contract with Gazprom. But as we experienced more than once, no contract guarantees the supply from the east. The current situation seems to have improved thanks to interconnectors and gas terminals. However, the necessary construction of gas pipelines networks and infrastructure is proceeding very slowly. Due to its shorter time of construction, (compared to coal fired power units and lower investment cost: which means cheaper financing), gas is the most beneficial fuel for new generating units (on average only two years are needed for project preparation and two for the construction). But there are also obstacles, inter alia, power generating companies have no knowledge of how to build gas power plants or how to negotiate contracts for the gas supply. Therefore, there aren't many decisions like the one made by Tauron and KGHM to construct the 800-910 MW facility in Kędzierzyn-Koźle, where two feasibility studies were undertaken, one for coal and the other for gas. The latter must have turned out better, since such the gas fired unit was accepted for implementation.

In 2012, ca. 16.5 billion m³ of gas will be available in Poland, which will set the absolute record. On the other hand, it will be only a bit more than the record consumption of gas this year – 14.4 billion m³. Theoretically these extra two billion cubic meters could allow for a start-up of ca. 2000 MW of new capacities based on gas, but such capacity will not drastically change the situation. Although a straight majority of experts and CEOs (not necessarily CEOs of power generating companies) herald the gas era and make big plans for electricity production development based on this fuel, reality belies such a trend. Currently, only two power plants are being built: (1) 400 MW for PLN 1.8 billion in Stalowa Wola by Tauron/PGNiG and (2) two power units 45 MW each by KGHM to meet the needs of the conglomerate plant. Why so few? The price of gas generated electricity is still much higher than the one produced from coal. Nobody can predict whether and to what extent it will change in the nearest future. Shale gas can potentially become a source of cheap electricity, but only after 2020 ... at the earliest.

RENEWABLE AND DISPERSED ENERGY SECTOR

In Poland the renewable energy sector includes mainly biogas plants and wind turbines. In 2010, ten new biogas plants with the total power capacity of 10 MW were put into service, their size ranging from 0.2 to 2 MW. The power capacity of all the Polish biogas plants currently in service amounts to 80 MW and in 2011, their capacity will probably exceed 100 MW. These figures are not significant enough to truly affect the power system. Meanwhile the development of wind farms encounters two main obstacles: access to the grid and rising public resistance. For these reasons no considerable changes may be expected in 2020 in these sectors. However, the share of these sources will gradually increase.

NUCLEAR

In 2020 I do not expect a nuclear power unit operating in Poland; and most likely, we will not start importing nuclear energy from neither Lithuania nor Kaliningrad. However, a nuclear power plant has many advantages: it is a well recognized technology which may compete

with renewable sources in terms of greenhouse gas emissions, overall construction cycle, lifetime and demolition, as well as its capability of providing significant quantities of electric power.

SUMMARY

Due to a very uncertain investment environment, accurate forecasting is very difficult. Already at the end of 2011 it will be possible to have a better assessment of the situation, but the “forecast of this forecast” indicates that investments will start, to a certain but very small extent in 2012, and that these will be mainly in gas technologies followed by supercritical coal ones, biomass and eventually wind turbines. The building of a nuclear power plant still remains under doubt. To a small and moderate extent, gas will replace some coal in the energy production market. At this point it can be stated that the power generation structure in the Polish power sector is unlikely to change significantly before 2020. The old approach

based on the saying “it will work out somehow” is dominant. For the time being, quotations from the energy market (Polish Power Exchange) do not reflect the threat of a rapid price rise brought about by the last stage of ETS implementation. The electricity price in the base load contracts for 2012 is only a bit higher than the present one, and the prices suggested for 2013 are only 10% higher.

Judging from historical trends, new technologies will help replace coal, oil and gas with cheaper alternatives before these resources run out. However, a transition to new energy sources requires time and the attempted endeavours of the EU and state regulations appear, at least to the Polish power sector, to be nothing more than wishful thinking and in complete disregard of reality. Indeed, if history teaches us anything, is that change occurs incrementally over time and not in leaps and bounds.

The author would like to thank Leszek Kąsek for his comments to the draft version of the text. All errors are the author's fault.

HOW TO LIBERALIZE THE POLISH GAS MARKET?



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The gas market is usually perceived from two perspectives – energy security and liberalization. In the economist’s eyes these two seemingly separate approaches intersect at the point which is defined on one hand by the availability of good quality, cheap resources that benefit the industry, power sector and households; and on the other, the assured and secured access to the above. It seems today that the Polish gas market is far from this achieving this point. It sluggishly endeavours to rid itself of the historical circumstances (both pre 1989 and the twenty years which succeeded it) that placed it in a position of fragile balance.

INSTABILITY OF THE GAS MARKET

There are a few reasons for this instability. The basic one is undoubtedly Poland’s dependence on the gas import from only one source (Russia), which covers ca. 70% of the domestic consumption. This gives the supplier (Gazprom) a more powerful bargaining position during price negotiations, which in turn translates into a relatively high price for Russian gas, especially when compared to other European markets; in which Gazprom has to compete with fuels provided by other suppliers. The latter especially alludes to the US’s

mass scale exploitation of its shale gas deposits, which due to excess supply outpacing domestic demand, lead in recent years to large quantities of cheap liquefied natural gas (LNG) appearing on the market. In countries with LNG reception terminals and pipeline infrastructure, the relatively expensive Russian gas has become unattractive, and Gazprom had to lower its prices. In Poland, this was not possible. As a result, according to the data made public by Interfax agency in February 2011, our country pays for Russian gas approximately 10-25% more than Germany or France.

Gazprom’s high bargaining power vis-à-vis Poland has its roots in long-term infrastructural negligence; the result of which is that the Polish gas network is functionally incapable of quickly replacing Russian gas with imports from other sources. In view of liquefied gas’ falling prices on the world market, the major weakness in this area is that our country has no transshipment terminal facilitating the import of significant quantities of LNG from the Middle East. Moreover, another serious problem is the interconnector deficiency on the western and southern Polish border (there is only one with a limited flow capacity), by which it would be possible to supplement deficits in the supply of Russian gas, e.g. in a situation of suspending the supply as a result of disputes between Russia - Belarus or Russia – Ukraine. Indeed, these were to be observed in recent years almost every winter. It is symptomatic that the price of Russian gas has increased by more than 10%, brought about by market pressures (autumn 2010), this state thus threatening a short-term cut in gas supplies if Poland did not agree to consenting to changing the method of calculating the gas price. Therefore, in its current situation, Poland has no prospect for either securing supply or ensuring a low gas price for end consumers.

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TPA PRINCIPLE

The above is only one many reasons rendering the Polish gas market's stability precarious. Another, no less important problem, seems to be the dominant role of the state owned entity (PGNiG) which controls, directly or indirectly (through subsidiaries), nearly 100% of domestic production, storage, transmission and sale of natural gas, both imported and domestic, to individual customers. This structure of the gas market in Poland has not changed despite the fact that in strictly legal terms the Polish market is governed by the TPA principle i.e. third party access to transmission infrastructure, enshrined in the Polish Energy Law. As a result of the combination of the infrastructural, institutional and regulatory factors, said principle, even though strongly anchored in the European law through the Energy Charter Treaty ratified by Poland in 1994, is not implemented in practice.

The reasons behind this situation are mainly economic and geopolitical. The ownership and organizational transformations in the gas sector were conducted by the Polish government in a very conservative manner, which has not yet resulted in developing a market where several entities would have to actually compete against each other to win customers. In relation to imported gas, this situation is additionally reinforced by the law, which requires maintaining a gas reserve corresponding to a certain percentage of the imported volume. In the situation where all of the limited storage capacity is in the hands of one entity, and developing new storage capacities is not profitable for the competing companies, the requirement to maintain the reserves effectually prevents the effective liberalization of the gas trade and market development.

This state of affairs is also affected by the problem with regard to the execution of the TPA's principle vis-à-vis the Yamal-Europe gas pipeline (by which Poland imports most of its gas). Said pipeline is managed by the company EuRoPol-Gaz, in which PGNiG and Gazprom each have 48% of the shares, with Gas Trading (a private company) owning the remaining 4%. This means that the practical implementation of the TPA principle on the Polish market, in the case of the Yamal-Europe gas pipeline, is dependent on the agreement between the Polish and Russian parties. Since the main goal

of Gazprom for many years was to sell gas to the large German market, it was hard to expect them to be interested in reducing the capacity of the Yamal-Europe pipeline in favour of third parties. With the Nord Stream pipeline shortly coming on line, it is likely to change this state of affairs and may facilitate the TPA's implementation, allowing other importers of Russian gas to make use of the pipeline. However, as the German example shows, they will probably be companies in which Gazprom has a significant, if not dominant stake.

The institutional consequence of the situation described above is that Poland is now burdened by the Energy Regulatory Office (ERO), a body with overarching powers far beyond those of its original remit. It has now *de facto* become the "creator" of gas prices for end consumers, and particularly for households.

Although this function performed by the ERO is reasonable when taking into account the structure of the Polish gas market and its infrastructural, regulatory, and institutional "bottlenecks", it stands in sharp contrast to European Union law. The latter provides rules for the gas trading market, and thus assumes implementation of mechanisms to determine the prices by balancing the demand and the supply provided by many independent, competing entities. It is true that the EU allows exceptions to this general rule. However, these must be justified by an important social need and refer to a clearly defined and limited group of recipients, such as poorer households or small businesses.

We must be aware that the practical implementation of the TPA principle in many other EU member states proceeds with similar difficulties. The problems are similar to those encountered in Poland - barriers in transmission infrastructure across national borders combined with a strong market position of one (Gas Natural, Spain), or (more often) two entities (GdF and EdF in France, EON and RWE in Germany). Even though in principle and in the vast majority of European countries the customers can choose a gas supplier, in practice this choice is limited by the market structure. Key players try to maintain their position in their national markets whilst at the same time taking advantage of the liberalization of markets in other countries. This process will gradually lead to the increased competitiveness of the

European gas market. However, it is still far from completion. The problem, which poses the most difficulties vis-à-vis the implementation of the TPA in principle implementation, remains the fact that in most countries, the big players' market power is such that they hinder the possibility of other smaller companies entering the market. For example, the fixed cost of building new pipelines is prohibitive and end up being a huge disincentive to enter the energy sector. However, the National Balancing Point's activity in the UK (which is growing by several dozen percentage points each year) and in other similar platforms in Europe, where the title to the gas that is already being transmitted can be sold, evidences the Community's gradual market liberalization. Poland, so far, is clearly lagging behind, creating a separate, effectively isolated domestic market, where the responsibility of the regulatory organ is greater than that of any other member state.

THE ROLE OF THE ENERGY REGULATORY OFFICE

Before 2007, the ERO ensured that the cost of gas to end users ended up being lower in Poland than in Germany. However, if PPP (purchasing power parity) were used to calculate the above then both values would equate. This was possible as the ERO shaped the intermediate price between the more expensive Russian gas and the cheaper (though not in market terms) Polish gas. The situation was somewhat modified with the fall of wholesale gas prices on the world markets, when in Western Europe Russian gas began to confront the cheaper competition in the form of liquefied natural gas from Qatar. This downward pressure resulted in a gas price decrease for both industrial customers and consumers in Western Europe, but not in Poland. As a result, gas has become relatively more expensive (after taking into account the purchasing power parity) in Poland than in neighbouring Germany.

From an economic point of view, in a situation where there are no effective, technical possibilities of accessing the networks by competing entities, the price regulation by the ERO appears to be fully understood. Some experts believe, however, that a fallout of this, is the lack of motivation to expand the gas transmission infrastructure from Germany. If that happened, the ERO would have lost an argument for regulating prices (thus losing its control over a monopolistic market structure), which due to simultaneous Polish dependence on Russian gas (the main distribution

companies in Germany are partially owned by Gazprom and deal with Russian gas sales), would effectively cause price increases. So we find ourselves in a vicious circle. The fear of rising prices and decreasing energy security prevents market liberalisation, and its absence in the long run is detrimental to consumers and Polish companies - especially in the chemical and steel industries.

HOW TO LIBERALIZE THE POLISH GAS MARKET?

Liberalisation of the Polish gas market is indispensable if we want this market to become competitive in Europe. In this situation, the expansion of the gas port, transmission and storage infrastructure are crucial. Although the process will be gradual, any extra time will be utilised in developing a top-notch competitive market.

This challenge involves first of all construction of an LNG handling terminal whose main task would be to create a viable market alternative to Russian gas, thus engendering real competitive pressures which will kick-start the Polish gas market. Secondly, it would be desirable to extend the over ten thousand kilometre long gas network in Poland, not only to provide a connection with the LNG terminal, but also to include additional interconnectors with the networks on our western and southern (and perhaps also south-eastern) borders. This would increase the bargaining power of Poland vis-à-vis foreign partners, since none of them would have a technically guaranteed dominant market position. Thirdly, it would be reasonable to consider an expansion of gas storage facilities by the state. These should be owned by entities other than the companies dealing with gas trading and transmission. This would allow an effective implementation of the TPA principle without compromising Poland's need to maintain reserves that enhance its energy security. Indeed, history has demonstrated the merits of such a scheme, punishing those that did not have the foresight to anticipate a situation of shortages brought about by fluctuations in foreign gas supplies. Alternatively, we might consider abolishing the requirement of business entities to hold reserves, transferring that responsibility to the state and the taxpayer.

Another problem associated with the need for infrastructure development can be its impact on gas prices. From an

economic perspective, capital expenditures that do not increase distribution possibilities (only allowing for supply diversification), will have the effect of increasing prices for end consumers unless said cost is offset by increased competition (the latter system, by its inherent nature reduces prices). Neutralizing this effect would be possible if a greater proportion of the investment was covered by taxation. Then the infrastructure cost internalization would burden the entire economy, not just that part that uses natural gas in production. An opportunity for the infrastructure development may also be connected with the high priority for the energy infrastructure, in its broad-sense, stipulated in the Community's strategic documents (Europe 2020 strategy). It may make it possible for Poland to access EU structural funds, using these as a source of financing the infrastructural changes in the Polish gas sector. This option is worthy of consideration. However, due to the intense competition for scarce public funds, equally needed for transport and electricity infrastructures, it seems unlikely that this investment financing plan will come to fruition.

WILL THE LIBERALIZATION BE BENEFICIAL TO CUSTOMERS?

Whether the gas market liberalization would be beneficial to households and small businesses also depends upon whether the Polish gas market will grow in the future. Bigger markets attract more suppliers, which exerts pressure on the drop in wholesale and retail margins and therefore prices. On the European scale, the Polish gas market is small. The average Pole consumes significantly less (ca. 365 m³) gas than the average Frenchman (ca. 710 m³), Czech (ca. 830 m³), Spaniard (ca. 850 m³), German (ca. 1000 m³) or Briton (ca. 1500 m³). There seem to be three reasons explaining this state of affairs.

Firstly, the gas price paid by retail customers is relatively high in relation to the average Polish household income and the productivity of small and medium enterprises." This reduces the whole country's demand for gas. This situation could change if a wider access to unconventional energy sources becomes possible, thus bringing down

retail gas prices for households. Secondly, because of the lack of infrastructure, a significant portion of households have no access to gas. The gas available from the national grid, can only be accessed by less than 80% of the population of Polish cities and far less than this figure in rural areas. In the case of scattered development it is hard to expect a significant improvement in this respect, although some expansion of the distribution network still seems possible. Thirdly, and most importantly, the relatively low gas consumption in Poland is affected by Poland's coal-oriented energy sector. Indeed, the prospects of the gas market in Poland are heavily dependent upon the Polish energy sector's favoured choice over the next two decades (i.e. the choice broadly lies between coal and gas).

Currently, the power industry uses only 10% of the domestic demand for gas. If, however, some of the coal units were replaced with lower emission gas power plants, that percentage and consequently the gas consumption in Poland would be greatly increased. This would be a revolutionary change in relation to the trends of the last two decades, during which the consumption of gas in our country has increased by merely 30% - significantly less than in other European countries. Having taken into account the relatively low gas prices on the world markets, the lower carbon output generated by gas fired power plants when compared to those fired by coal, as well as the very real prospect for the introduction of carbon tax charges (emission fees) in the energy sector over the next ten years; a significant increase in demand for gas does not seem unlikely. This situation should encourage new investments in transmission infrastructure and increase the incentives for new companies to enter the Polish market. If the Polish state has successfully built an LNG handling terminal and if, concurrently, adequate storage facilities have been constructed (or mandatory reserves abolished), then, it would not be unreasonable to expect by 2020, a Polish gas market that has not only increased its comparative import in the country's energy balance by several dozen percentage points, but equally become much more competitive than it is today. Will customers benefit from it? Why would they lose?

SHALE GAS IN POLAND AND THE NATIONAL ENERGY BALANCE



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As a result of the disaster at the Fukushima Daiichi nuclear power plant, Japan has decided to temporarily shut down 11 of its 55 nuclear reactors. Assuming that only 6 reactors in Fukushima will be permanently closed, the electricity loss will amount to ca. 6000 megawatts, i.e. 10% of the power produced by the nuclear power plants in Japan (pre-tsunami). This raises the obvious question - what will replace it?

Christopher Helman, based on data taken from the Energy Information Administration (EIA), provides the following estimates for the reconstruction of power capacities, assuming that the shortfall is met solely by one technology:

- gas - by far the cheapest option. 8 ultra-modern gas and steam power plants would cost \$ 6 billion or 7

billion in the event of having to import liquefied natural gas (LNG);

- wind - from 4200 to 6000 turbines would need to cover an area of approximately 40,000 hectares for the price of \$ 11-18 billion;
- nuclear energy - the cost of 6 nuclear reactors is estimated at \$ 14 billion;
- coal - 15 low-emission, supercritical coal-fired power plants would cost \$ 21 billion. If the plant were to be constructed in the CCS ready version (to allow carbon capture and storage), the cost would rise to \$ 30 billion;
- solar - the most expensive option. To obtain 6000 MW from a solar power plant, Japan would have to cover an area of about 32,000 hectares with parabolic troughs, the cost of which would range from \$ 24 to 40 billion. Another drawback is that solar power plants (like wind turbines) cannot be the basis of the power system, because they only generate electricity when weather conditions are favourable⁴.

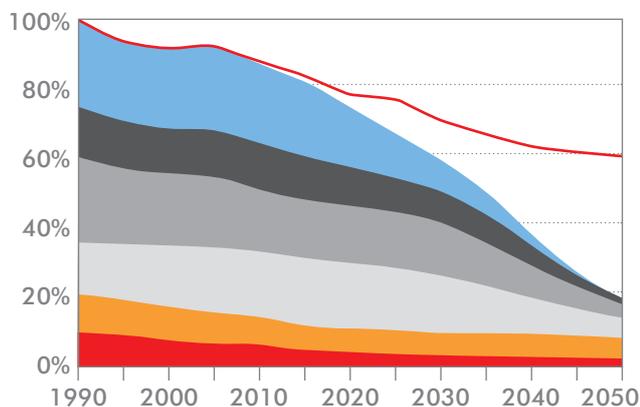
Which technology will Japan choose? One can be sure that they will take into account factors such as the cost of installation, start-up time, availability of raw materials, environmental impacts and public opinion. The choice of gas power plants is beneficial because of its low investment costs, short construction time, ability to operate as the power system basis, and at the same time is able to provide a source of peak power. Finally its greenhouse gas emissions are half those of coal-fired power plants. This last factor is important, unless Japan suspends its climate policy and the implementation of the Kyoto Protocol's commitments. The need to import LNG and the resulting increased dependence on foreign supplies, as well as the possible effects that price fluctuations may have on the economy, weight against this option.

As a result of the natural disaster, the Japanese energy sector has faced a dramatic situation requiring immediate decisions, actions and heavy investment. This situation is almost identically mirrored by Poland's energy sector. Although the latter country has not undergone a diluvial catastrophe, it too faces a multi-million dollar infrastructural overhaul. This is not only necessary due to its continuous neglect in updating power generating capabilities but equally because EU regulations deem these upgrades necessary to meet emission reductions targets. As an aside, these investments should start ASAP. The question thus facing Nipponese and Polish policy-makers is identical: "what sources of energy should we use?". Their implementation should start ASAP. The question facing policy-makers are identical: "what sources of energy should we choose?".

ENERGY SECURITY IN THE EUROPEAN UNION

The disaster at the Fukushima plant also sparked debate amongst European politicians in regard to the Community's future electric power structure. Germany opted for a temporary shut-down of 8 of 17 operational nuclear reactors and plans to rid itself completely of nuclear energy. Heated discussions on the safety of domestic nuclear power industry started in France, whilst at the same time,

Figure 1. The path to achieve the 80% reduction in greenhouse gas emissions in the EU by 2050



Source: COM (2011) 112 final

the European Commissioner for Energy, Günther Oettinger, spoke in favour of carrying out security checks in all EU nuclear power plants as well as called for coordinated international discussions on the future of nuclear energy. Thus, this power sector has been under a huge pressure.

At the same time, the European Commission has been consistently striving to reduce greenhouse gas emissions in the Community. In December 2008, Europe adopted the Climate and Energy Package. At the beginning of March 2011 another strategic document on the Community's climate policy was published: "Roadmap for moving to a competitive low-carbon economy in 2050" which stipulates the goal of reducing greenhouse gas emissions in the EU by 80% (relative to 1990) by 2050 and reducing greenhouse gas emissions from the energy sector to zero (Figure 1.).

The obvious question that arises, is how Europe intends to achieve such ambitious climate targets. And how will Europe's fuel structure change under the climate policy? The time horizon of 2050 seems quite remote, but for economically efficient and effective implementation of the EU policy, both businesses and Member States must now make decisions regarding investments and the choice of energy sources for the future. In this discussion, there is still one very important aspect - energy security and independence of individual member states and the Community as a whole.

In the "Second Strategic Energy Review"⁵ the European Commission acknowledges that all activities under the Energy and Climate Package, namely:

- the massive shift to high-performance, low-carbon energy technologies;
- the implementation of tools for energy efficiency;
- the use of CCS technology on an industrial scale, will not be sufficient to ensure needs of the EU's energy security. Additionally, any significant expansion of nuclear energy in the Community is a very big "if". Consequently, the EU must optimize the use of its own, optimally low-carbon energy resources, without prejudicing the role of non-conventional energy resources.

⁵ Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Regions. The second strategic energy review. EU Energy Security and Solidarity Action Plan. COM(2008) 781 final.

THE CONDITIONS FOR SHALE GAS EXTRACTION IN POLAND

Parallel to the exploration and research works, other aspects of the gas sector expansion require urgent attention. These are as important as the extraction technology and will determine the profitability of shale gas production. These are:

- creating effective legal regulations in the gas extraction, transmission and distribution sectors;
- ensuring demand and building the necessary infrastructure;
- making a reliable analysis of the environmental impact;
- persuading the European Union to include shale gas in the European climate and energy policy;
- creating a model of shale gas sector development in Poland;
- partnership with more experienced (mostly American and Canadian) partners.

CREATING EFFECTIVE LEGAL REGULATIONS IN THE GAS EXTRACTION, TRANSMISSION AND DISTRIBUTION SECTORS

The high costs of searching for unconventional gas, the high risk of failure and the limited range of technological know-how, means that the development of extraction and exploitation of unconventional gas resources must, in part at least, be undertaken by foreign capital investors. The situation is now different from that of the past, when the extraction of fossil fuels was the domain of companies whose capital was in major part state-owned.

The challenge that is now facing state authorities, is the creation of an effective system consisting of legal regulations and supervisory institutions, all of which will create conditions that foster investment. However, it must also uphold environmental safety standards, secure the nation's financial and economic interests, ensure that dividends are paid to the State Treasury and that end consumers are not extorted.

It is in the interest of all these groups that such a legal system be quickly created, because then the benefits from

the new shale gas sector will be greatest. Until the completion of drilling, any operations will of course be conducted under conditions of uncertainty. Nevertheless, the rational approach requires that we be ready with the necessary regulations in the event of success, instead of waiting for confirmation that we do indeed have suitable deposits for cost-effective exploitation.

AT WHAT STAGE OF THE SYSTEM FORMATION ARE WE?

It seems that we are still at the beginning of the road. What is missing is a new energy strategy that would focus on the development of the gas sector and different scenarios of shale gas exploration and distribution. There is an urgent need to revise the “Energy Policy of Poland until 2030” document, but it is also equally necessary to prepare the Polish response to the EU’s “roadmap for moving to a competitive low-carbon economy in 2050”. The Energy Policy of Poland until 2030, did not stipulate increasing the gas share in the energy structure in order not to increase the Polish dependence on external sources of fuel. According to the information coming from the Ministry of Economy, the “National Programme of Greenhouse Gas Emission Reduction by 2050” contains a diagnosis action plan which includes proposals for legislative changes which would indicate the sources of funding and support instruments, as well as methods of verification and reporting. These should be ready by March 2013. Due to the various demands coming from various quarters, the Program will be prepared with the participation of all the stakeholders, i.e. other ministries (including the ministries of the state treasury, infrastructure, regional development, science and higher education, agriculture and rural development, finance, education, internal affairs and administration, foreign affairs, and government agencies such as National Administration of the Emission Trading Scheme (KASHUE), National Centre for Emission Management (KOBIZE), Central Mining Institute as well as chambers and business associations with the Social Council of the National Programme for Reduction of Emissions at the forefront. The aim of the National Programme is “to develop a low carbon economy whilst ensuring the sustainable development of the country”.

11 *Ibidem*.

The first public debate on establishing an energy balance for Poland is planned for October 2011. Further discussions are to take place from June to September 2012. Certainly an important element of these debates will be the share of gas in the energy structure and, according to the adopted strategy, the preparation of proposals for regulations concerning gas extraction, its transmission and distribution. Consideration should be given to the choice of a 'gas use scenario'. This may be a centralized model based on large power generation units and gas pipeline networks or a decentralized model based on local plants as well as gas transportation.

In April 2011, the Polish Sejm passed and sent to the Senate the amended Geological and Mining Law, which defined the rules for unconventional gas extraction. This law establishes clearer terms of operation for entities applying for licenses for exploration and fossil fuel exploitation. Firstly, the administrative procedures have been simplified and the decision-making body for investors is now the Ministry of the Environment. Secondly, it introduces a provision entitling the entrepreneur who received a license for gas exploitation to demand a buyout of the property. He may, if he so wishes, buy only part of the property i.e. that part which will be used for mining purposes. This also includes that part of the property necessary to perform the intended activity. Thirdly, the one who identified the mineral deposits, and documented it in sufficient detail to enable the preparation of the deposits' extraction and obtained a decision approving the geological documentation of that deposit, has priority before all others in establishing a mining usufruct.

This last provision means that the entrepreneur who took the risks and costs of exploration may receive a license for the gas extraction in the tender free procedure; thus greatly increasing investment safety.

The act also establishes the fee rates, including the exploitation fee, and specifies that 90% of the above's proceeds shall constitute the income of the local administration units (gmina) in which business is conducted. The remaining 10% shall go to the National Fund for Environmental Protection and Water Management.

Poland has adopted an optimal policy, under which the licenses for gas exploration are cheap so as to encourage

investors to operate and take some of the risk. Maximization of budgetary revenues is to take place at the stage of exploitation. Choosing the right tax regime needs to be debated. Nevertheless, from the perspective of the mining companies, the rates level is as important as ensuring the fiscal stability of the system during the licensing period.

The act and its related regulations also contain the rules and environmental safety control guarantees. It can therefore be concluded that shale gas exploration and production segment will be well regulated, shortly after the end of the legislative process.

And what about the transmission and distribution segments? In Poland there is no real gas market, rather there is a monopoly with regulated gas sales prices difficult to access, let alone break by new market entrants.

Creating the conditions for the development of competition is indicated as a strategic objective, both in the Polish Energy Policy and the Energy Law. Adoption of the Gas Act and the implementation of the third energy package is expected to take place in 2011. The purpose of the gas directive is to liberalize the gas market and create a uniform gas market in the EU.

The industry and energy sectors have for years been reiterating the following demands:

- abolishing the importers' obligation to maintain gas reserves;
- releasing the access to import pipelines and their extension;
- abolishing tariffs for gas products because the price regulation in gas trading does not provide:
 - adjustment of tariffs to changes in crude oil price quotations;
 - rapid adjustment to the gas quotations on wholesale markets;
 - adequate response of tariffs to changes in exchange rates;
 - developing the spot market for gas, which is needed for flexible gas power plants.

Liberalization of the gas market is a prerequisite for the development of a power generation industry based on gas.

Without it, there will not be buyers of shale gas in amounts that would make the extraction economically viable.

ENSURING DEMAND AND BUILDING THE NECESSARY INFRASTRUCTURE

There are three potential ways using of shale gas: (1) increasing domestic consumption, (2) replacing imports, and (3) exporting it. However, what it is worth noting is that without investment in the gas power industry, the additional gas demand will be so low that it will not be an appropriate stimulus to the development of gas extraction from unconventional sources¹².

According to the Energy Market Agency, ca. 7000 MW will be put out of service in Poland by 2020, and after 2020 another 7,500 MW. This means that there will be a need to replace almost half of the existing generating capacities with new units. The Institute for Energy Studies estimates that the replacement of coal power plants with gas-fired ones will be economically viable when the price of CO₂ emission allowances exceeds EUR 20-30, something which is bound to happen after 2013.

The power companies' plans (each of these at different stages of completion and with no assurance that they will come to fruition), show that they want to build gas-fired units with a capacity of 3000 MW. Another 6,000 MW of capacity, according to the Polish energy policy, is to be provided by two nuclear power plants (3000 MW each) by 2030. The rest of the disabled capacities should be replaced mainly by distributed, renewable energy sources and coal fired power plants.

The gas units, now planned, with a capacity of 3000 MW will generate an increase in demand for gas by 2.7 - 4.1 billion m³ ¹³. Even if a small part of that forecast is implemented, the emergence of shale gas could encourage further investment – one of which could be to replace the second nuclear power plant with gas units and distribut-

ed co-generation. The development of the gas sector (for use as peak power production) will also be justified by the strong development of RES. In the longer term, the increased demand for electricity will also result from the development of electric transportation.

From what can be extrapolated from the conservative scenario, one can assume that the power sector demand growth for natural gas will be, by 2020, in the region of 3-4 billion m³ per year. If progress is made in the development of unconventional sources gas extraction¹⁴, it is possible that its demand could double to more than 9 billion m³.

The obsolete energy sector, which requires a thorough modernization: and the ambitious European Union's climate policy are both the external conditions that may be an impulse for investments in gas power plants. Unfortunately, there is no clear sign of government support for such an overhaul of the energy sector. On one hand, the Ministry of the Environment promotes the process of exploration and exploitation of shale gas in Poland. On the other, the government is preparing a draft of the Strategy "Energy Security and the Environment - the Prospect of 2020"¹⁵, in which the unconventional gas potential is merely mentioned. It must be noted that entrepreneurs, who today make decisions on investments in the energy sector without a guarantee that the government will know what to do if shale gas extraction proves viable, will not be likely to invest in gas related projects.

In addition to the energy sector, a second outlet for this gas is export. The demand for Polish gas would of course be dependent on its price. Another barrier to overcome is the lack of transmission infrastructure.

Making use of domestic and foreign demand will depend on the removal of another barrier, the underdeveloped transmission network. Not only are its transmission pipeline capacities inadequate; it equally lacks the capability of

12 Maciej Kaliski, Marcin Krupa, Andrzej Sikora. "Potential of the Polish electricity market as a possible direction of Polish shale gas monetization".

13 *Ibidem*.

14 *Ibidem*.

15 Draft of 4 May 2011 http://www.mg.gov.pl/files/upload/13281/BEIS_ver_4_maja.pdf

entering the system in some shale gas extraction areas, and in some cases (represented as ‘white spots’ on electricity maps of Poland) the gas transmission system is simply non-existent. At present, the transmission system is not able to provide efficient transportation, even for a moderately optimistic demand growth valuation (5 billion m³/year) and an even less optimistic one for gas export development.

Today, there are no technical possibilities to export gas through Poland due to the unidirectional nature of the transmission. This allows only for transportation to Poland without the reverse option¹⁶. In order to realize this potential, the government should wait no longer to create a plan for Polish gas exports, and then provide the formal and legal framework for the construction of export infrastructure. Perhaps the purpose of the LNG terminal built in Świnoujście will be for gas export and not for gas import.

MAKING A RELIABLE ANALYSIS OF THE ENVIRONMENTAL IMPACT

Gas extraction from unconventional deposits, like any industrial process, could pose a threat to the environment. There are defined risks that are associated with interference in the landscape, noise emissions, emissions to the atmosphere and disturbing the hydraulic balance¹⁷. The greatest controversy involves the use of large quantities of chemical-rich water used in the process of fracking the shale rock. 200 tankers full of water are required for just one shaft¹⁸.

However, the companies dealing with shale gas extraction assert that modern fracking methods are environmentally safe and pose no threat to drinking water resources¹⁹. Moreover, the Ministry of the Environment published a document which states that “Poland is ready to fully control the exploration process as well as the extraction of shale gas in the future, owing to our good

laws, systems and institutions which monitor the state of the environment e.g. as regards the water management and environmental impact assessments for projects”²⁰.

Notwithstanding these government assurances, continuous monitoring of the latest information and research results related to the environmental impact assessment of shale gas is recommended. To this end, the government should cooperate with the EPA²¹ and other institutions that carry out advanced work on the environmental impact assessment of the hydraulic fracturing technology.

Parallel to these activities, the government should prepare a thorough public awareness campaign, aimed particularly at providing the local communities that inhabit the areas of potential unconventional gas sources, with a cost-benefit analysis which will, without bias, present the opportunities and risks associated with shale gas extraction, underlining what effects such extraction will have on the Polish economy and society.

PERSUADING THE EUROPEAN UNION TO INCLUDE THE SHALE GAS IN THE EUROPEAN CLIMATE AND ENERGY POLICY

The European Union should make optimum use of its own energy resources with a view to improve energy security and the implementation of the EU’s climate policy. In this context, it is very important that the EU perceive shale gas as a potential energy source that will help improve the Community’s energy independence, and as an important element aiding in transforming EU economies into low-carbon copies of themselves.

However, the European Commission is considering scenarios of energy production based 100% on renewable energy sources. This lacks economic or technological rationale.

16 Maciej Kaliski, Marcin Krupa, Andrzej Sikora. “Restrictions and barriers to the Polish gas market and infrastructure in the context of the possible development of shale gas extraction in Poland.”

17 Wojciech Stępniewski, presentation titled: “Environmental aspects of shale gas extraction”.

18 Adam Czyżewski, Paweł Świeboda. “How to build a shale gas sector in Poland”.

19 PKN Orlen S.A.”Shale gas. Basic information.”

20 Ministry of Environment. Environmental safety guarantees for exploration and extraction of unconventional natural gas deposits (so-called “shale gas”), 09.05.2011.

21 Environmental Protection Agency.

The Commission assumes that the use of fossil fuels would only be possible if Carbon Capture and Storage technology is applied. This technology is, as of now, still in a demonstration phase and most probably will not be available on an industrial scale in the coming years. On the other hand, the European Commission's representatives do not want to take into account the potential of unconventional gas deposits, therefore not wishing to mention it within the EU's energy market's documents. The explanation they offer for the above, is that there is a paucity of European experience in the area of shale gas extraction, especially when compared to that of the United States²².

Formally speaking, in accordance with the EU regulations, each member country is free to determine its energy structure. The period of the EU Presidency should be used by Poland to deepen the debate with regard to the EU's target of energy balance and ways to achieve it; taking into account both the European level as well as that of the individual member state. The required solution must guarantee that the same importance be given equally to meeting the EU's CO₂ emission reductions as that of maintaining the EU's competitiveness. Poland, having the great advantage of being laden with unconventional gas reserves, has a sufficient mandate to at least set the tone of the debate. It can use this mandate to advocate an increase in the EU's energy security, by putting to better use its domestic resources. The Polish government's diplomatic initiative to oppose any possibility of introducing an EU's moratorium on shale gas extraction is a step in the right direction. The recent decision to withdraw or suspend nuclear programs made by several of the Community's countries has resulted directly from "the Fukushima effect"²³. It rekindled the interest in fossil fuels, which, at least during the transitional period, would replace the decreasing capacities of nuclear power plants and thus form a "backup" for renewable energy sources. This is a good moment to start a pragmatic discussion on the role of fossil fuels in the European energy sector. This discussion must not only include extraction issues, but

also the expansion of the European gas transmission infrastructure. The latter should be converted from a transmission corridor model to a network of European hubs and connections, which ensures the security of gas supplies to customers, rather than reliance on one supplier.

Parallel to the actions taken at the European level, Poland is determined to deepen cooperation with the United States; an obvious partner in the exploration and exploitation of unconventional gas. In May 2011, during the Polish-American summit, the program of such a cooperation was outlined to include research, staff training, environmental protection and creating a business framework conducive to gas extraction. It also covered the cooperation of Polish and American geological survey services, which will result in a report from the Polish Geological Institute planned to be published in September 2011, presenting the estimates of unconventional gas resources in Poland. It will be possible to compare them with earlier estimates made by commercial companies. In autumn 2011, another Polish-American Business Summit is planned, which will be devoted to the gas extraction sector. American businesses emphasise its high interest in the Polish gas market.

READY FOR SUCCESS

Today is the time for Poland to make the decision on the shape of the future structure of its energy sector - it can choose coal with the CCS technology, nuclear energy, renewable energy sources or gas. What investors will ultimately choose is unknown. But we do know that the information on the potential domestic unconventional gas deposits has seriously affected the thinking about development strategies. In addition to the certainty that these gas resources are at hand, investors need, a guarantee of demand, a stable legal framework as well as political support for shale gas. All this must be done before we obtain detailed data on shale gas resources in Poland. Otherwise, the economy will not be able to absorb the additional volumes of gas and the shale gas sector will ultimately remain a missed opportunity.

22 Adam Czyżewski, Paweł Świeboda. "How to build a shale gas sector in Poland".

23 Germany took the decision to close all the nuclear power plants by 2022, which now generate 24% of the power. A similar decision is considered by Switzerland by 2037. In a referendum held in Italy, the majority of citizens voted against the nuclear program. A referendum in Poland is requested by the Minister of the Economy.



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