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What Change Can The New Developments In Energy Sector Bring Into the World`s Energypolitical and Geopolitical Order?[footnoteRef:2]‡ [2: ‡ The first version of this paper is presented at EECON-2014 (International Conference on Eurasian Economies, 1-3 July 2014, Skopje).]

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1Hitit University, Department of Economics Abstract.The recent developments bring US to a leading natural gas and oil producer position. The attempts in last 20 years to bring new horizontal drilling and hydraulic fracturing technologies together have developed a success in shale gas and oil production in US the production volumes has reached to a position to redefine the market. Last estimations are bringing more information about the shale capacities of the major basins of the world. However, the estimates are based on a wide range of assumptions and consequently their results vary in a large scale. In any case, these developments have crucial economic, political and geopolitical consequences on the energy market petroleum producer and consumer countries and regions. Despite the wide range of ambiguity of the estimated size of the resources, the estimations show US and North America has one of the biggest potential, already turning technology into the giant production numbers. Some of the estimations allege so big numbers can even mean to a new world order. The asymmetric nature of the potential, can also be said, increases some of the expected impacts too. In this study, basically, we want to supply an initial solid and economical evaluation to this ambiguity. We are trying to shape a frame for the new energy potential and to put it in a place in the current practice of the world. Secondly, in this context, we are underlying here some of the possible economic and geopolitical consequences each of which can constitute a subject of deeper study.

Keywords: Energy, Fossil Fuel, Shale, Shale Oil, Shale Gas, Natural Gas, Oil, Shale Boom JEL Codes: Q43, Q47, Q32, Q33, O13, L7I Introduction When the reports of a ‘new gold rush’ started to be aired in 2011 (Economist, 2013, p.59) it raised questions to what extent its size can reach. There are some voices that claim a big revolution for world economy with referencing the substantial oil and gas production rise has been experienced in USA (see, Morris, 2013; IEA, 2012). It is not easy to calculate how far the results of this new boom of energy production can be reach.

Energy has always been important for the economy and politics. There have been extensive political struggle for the energy reserves. The way of producing and consuming energy especially the fossil fuels which are highly dominant in the global economy and industry has been one of the important issues in this context. Economic development, technological innovations, industrialization and the new global issues (such as environmental issues) coming as its consequences have all mutual relationship with the energy concept; and make it more complicated and important for the current economic order of the planet.

Because the world economy is relying on mainly on the fossil fuels, the projection on its capacity or lifespan has been always important. Development and possible replacements of all other energy options,

such as alternative and renewable energy, have been reckoned according to the availability and the capacity of the primary option.

Because of these reasons, any change in this structure will have butterfly effects to industries and economies. The production boom in US suggests that kind of change has been already happening right now. Its results are already started to change the energy structure in America. The projections show that USA is about to being the biggest oil producer in the world. This change came very fast. To that extend the ambiguity on the final shape of the changing picture is extremely large. For example, after seeing an evaluating the first years of the shale gas and oil boom, Lieber (2012) can foresee just a substantial reduction in oil imports of US; while, others such as EIA reports can mention about an energy independency or a net energy exporter status for US in near future (see, EIA, 2014). IER (2011) estimate even more excessive resources, extends this suggested energy independency up to the level of centuries. The one thing which is crystal clear is that the claims about the changing situation and its possible results need to be brought into academic discussion.

The mentioned estimates are not only to change the capacity profile of the primary energy source but also to change the whole energy perspective. To that extend it is expected to have most important effects on economic, political, geopolitical effects. In this paper, trying to draw a macro frame for the size of the new energy opportunity, we try to evaluate it in the present global energy picture and suggest or estimate an importance of it. Conducting this type of premier suggestion we also want to call for further studies on the very important sequential areas. Second section borders the global energy picture in which we will evaluate the importance of the new developments. Third section tries to give the notion on the origins of the new boom. Section four conducts the quantitative and economic evaluation. Fifth section concludes the paper.

Energy Structure of the World The primal source of energy of the world comes from the sun. The total annual solar energy the earth is exposed to is approximately 5400 Q^[4]. The estimations about the amount of carbon processed via photosynthesis show about 5x10¹⁰ tones which equal roughly to 20 Q energy. It equals roughly 0.4% of the earth's annual solar energy intake^[5](Bolton, 1978, p.181). [4: Q (=quintillion Btu) =1000x quadrillion Btu (quad-[q])=10¹⁸ Btu (SCC, 1979, p.14) ≈ 10²¹ J.] [5: Although the solar energy excessive, it is intermittent, seasonal and therefore its efficiency is still low.]

Total world proved natural gas reserves have almost tripled to 6793 tcf^[6] in last 30 years (OGJ, 2012). Similar discoveries have also happened for oil reserves updating the numbers upward in the history (for example US has so far consumed 2.5 times much of the oil that is predicted as its total reserves 30 years ago, see IER, 2011, p.1) Total world proved oil reserves are 1342 billion barrels^[7] (IER, 2011, p.2). We can add roughly 1000 billion short tons^[8] coal to this picture, almost half of the recoverable resources being in US. These reserves are predicted to have potential to enlarge from 2 to 70 times for the North America case (see, IER, 2011) using the new developing technologies; this last argument is rather disputable and is discussed in Section 4. [6: Tcf: **TRILLION CUBIC FEET.** The exact conversion rate is, 1 tcf= 1.027 quadrillion Btu (AGA, 2014). We

use, however, rough conversion rate of 1 tcf= 1 quadrillion Btu (=10¹⁵Btu), for conformity reasons.] [7: Barrel of oil equivalent, BOE, is used as energy unit itself. The conversion rate to Btu is: 1BOE=5.8 x 10⁶ Btu. It is also equal roughly 5800 cubic feet of natural gas; or 6000 cubic feet of typical natural gas (USGS, 2000, Table AR-1). For our case, we can use, 1BBOE (billion BOE)=5.8 quadrillion Btu.] [8: 1 billion short ton (1000 lbs) coal=19530 quadrillion BTU]

The world annual primary energy usage is over 500 quadrillion Btu[footnoteRef:9] for the year 2010 (EIA, 2012); with almost 1/5 of it belonging to US consumption alone. About a 4/5 of the primary energy consumption is met by fossil fuels. [9: ORNL (Oak Ridge National Laboratory) calculations for the year 2000 is giving around 410-15 quadrillion Btu global energy consumption (<https://bioenergy.ornl.gov/faqs/index.html>). Another estimation gives 12-16 terawatt[hour] (ETC, 2011 p.79). 1TWh=293 quadrillion BTU.see ref 125 in ETC.]

Figure 2. Variety in energy production in US, 1960-2040 (quadrillion Btu) Source: EIA, 2014 As the numbers show that there is a big potential in terms of alternative energy resources. The environmental issues, national and international regulations will be the determining factor for this potential. On the top of that, there is the technological factor changing all parts of this equation. It is highly possible that the increasing usage of the alternative and renewable energy sources might trigger further new technological developments in these areas. However, as can be seen in Figure 2, a dramatic change is not expected in energy production scales in 30 years.

In this global picture, a quick macro level calculation will show that the world's proven reserves can supply energy roughly for 40-50 years[footnoteRef:10], without taking the new potential capacity into account. However, especially the short-term technical constraints and the 'peak oil' discussion on rising demand of oil shows the biggest pressure will be on oil supply part (for different views of discussion, see Hoong, 2012, pp.231-33; JFCOM, 2008, p.28; IEA, 2008). Regarding to that aspect, as Figure 2 and EIA predictions suggest, it can be expected a natural gas replacement to certain degree (see EIA, 2014, p.12-13) [10: Any micro level constraints or other technical evaluations are not considered in this rough calculation.]

Where Does Boom Come From?

Fossil fuels derive from decayed plant and animal matter trapped within the earth for hundreds of millions of years (Morris, 2013, pp. 18-19). Dead organic material accumulated under water and forms mud. Mud was compressed into sedimentary shale rock in time. This geologically slow process leads a transformation of the organic material to hydrocarbons[footnoteRef:11], chains of carbon and hydrogen atoms. [11: The simplest hydrocarbon chain is CH₄, methane which contributes one of the most abundant organic compounds in the world. Heavier hydrocarbons including four to twelve carbon and multiple hydrogens atoms are used in formation of gasoline; even heavier ones are used for the diesel form.]

Conventional oil reservoirs form if the liquid or gaseous hydrocarbons pass, by time, from the shale to a reservoir medium[footnoteRef:12] (or in some cases directly to the surface of the world). Shale rocks have been, however, stayed as unfeasible to exploit so far because they are generally formed as thin layers

situated very deep in the earth[footnoteRef:13]. [12: Therefore the original shale that traps and transforms hydrocarbons is called as source rock; and the more reachable medium such as sands from where the oil is drilled is called as reservoir rock.] [13: If thickness of the shale layer is thick enough it can be feasible even for the conventional drilling; on the other hand, hydrocarbons in the shale rock generally make up less than 6% of the rock weight (Morris, 2013, p.20). Given their usual thin layer thickness and deep depth occurrences, they have stayed out of the feasible scopes until the unconventional drilling methods developed.]

The technological advancement to change this fact came by the private American engineering attempts[footnoteRef:14] that unite the new technological developments of directional drilling and hydraulic fracturing into a replicable final engineering solution for shale well drilling. An important stimulus for this success can be proposed as the private mineral right ownership in America[footnoteRef:15]: in America, different from the most of the other world countries, mineral rights are associated to the land and belong to landowners. As a result of this technology becoming available we have been experiencing a substantial increase in shale oil and gas production in America. [14: G.P. Michell of Mitchell Energy Co., investing on its technology for a decade, completed their first successful horizontal well in Texas in 1991; and with further technological improvement achieved the first commercial production of shale gas in 1998.] [15: Government did play a role in the development of the new technology. The importance of this role can be change from different perspectives (for a different perspective see, Trembath et al., 2012).]

The similar technological developments also bring 3 other potential sources of unconventional gas and oil to the agenda: coal bed gases, oil sands and tight oil (oil shale). Some of them already started to be processed[footnoteRef:16]; however, they are not consisting comparable volumes as shale gas and oil in the US. Therefore, they are not assumed to either to have capacity to change the general picture of the global energy, nor are they calculated in the forecasts regarding to reckoning the new potential. [16: The most important oil sand production in the world is currently going on in Calgary, Canada. Out of Germany, coalbed gas production also recently started to be produced in various regions.]

Evaluations of Potential How big units we are talking about? What can be the economic value of this new imminent energy production boom? Of course, these questions depend on the quantitative estimations about the geological reserves and the qualitative estimations of these reserves. The quantitative estimations are not consistent and give a very cloudy picture us for the moment. In this scarcity of reliable data, for example, US Energy Information Administration's (EIA) estimations in same year, 2010 could be %50 different from each other. Having this in mind, we need to draw a quantitative and economic borders for the new energy opportunity we are being faced.

Technical Evaluations The primary energy consumption of US is 95 quadrillion BTU per year and is predicted to grow 12% by the year of 2040. 82% of that consumption is coming from the fossil fuels and this proportion is expected to change by only a 2% decrease in next 30 years (EIA, 2014). The world's total primary energy consumption in 2010 is over 500 quadrillion BTU and almost the half of this consumption belongs to OECD countries. This consumption is predicted to increase to 820 quadrillion

BTU and about 85% of it comes non-OECD countries, specifically China consists 40% of the total increase of primary energy consumption (EIA, 2013, Table A1).

So far, the consumption predictions are stable and seem having reliable projections in a viable range. The problem part lies in the resources part: the new shale drilling and fracturing technology created a new opportunity but the size of this potential is highly ambiguous. Below, we gave some examples of that variety.

Figure 3. **2 NATURAL GAS BY COUNTRY (TRILLION CUBIC FEET) SOURCE: IER, 2011**

Starting with the global proven capacity we pictured in section 2, we see that the world proved natural gas and oil reserves have reached the level of 6793 tcf and 1342 billion barrels respectively (see Section 2

3 FIGURE 3 & 4). USA had a 20 billion barrel proven oil reserves until a few years ago. After the new technology comes into the scene, IER calculates that the technically recoverable natural gas and oil resources of US are 2744 tcf and 1442 billion barrel respectively. ARI (2011) estimated the world recoverable resources of shale natural gas as 5760 tcf; ARI (2013) updated it to 6634 tcf for natural gas and 335 billion barrels for shale oil. EIA (2013) estimated 7299 tcf of gas and 345 billion barrels of oil. ARI (2013) estimates the US will have biggest share for natural gas and second biggest share of oil in the total world potential: for shale natural gas and oil are 1161 tcf and 48 billion barrels[footnoteRef:17]respectively. [17: ARI (Advanced Research Institute) states 37 tcf of shale gas and modest volumes of shale oil/condensate have been already produced and not included in the resource numbers (ARI, 2013, Attachment-B).]

Figure 4. Oil by Country (billion barrels) Source: IER, 2011 As we can see in a first glance, the capacity numbers for this new energy potential could be multiplied by a factor of 2.5-3 times for gas and 28-30 for oil. The estimates and predictions are based on various assumptions. Therefore, this difference causes from several assumptions that the institutions take to conduct the estimations and predictions. First of all, based on the basin information institutes make a total resource potential prediction mainly based on assumptions. Secondly, the institution has to make an assumption on the percentage of this potential can be recoverable. These critical points seem to cause this wide range of variation in predictions. EIA's another assumption depending on the current technology is also shaping the forecasts by giving the advantage on the gas production side. Therefore, it seems that unless another technological development changes the situation, the gas production with shale production will be the dominant component in the energy forecasts.

Over 72% of petroleum are used in transportation vehicles and heating. Coal, natural gas and petroleum are currently responsible for 67% of global electricity production (ETC, 2011, p.59). These a few numbers can show how the current structure of the economy is directly depended to the fossil fuels. To change this dependency is the most important motive for the research and development activities on the alternative energy issues. However, the quick shifting efforts needs tremendous human intellectual capacity and come with the huge financial costs. Therefore, related with the new developments, a possible change in the perception of the emergency level of the need of any structural transformation will be crucially important for the future of all energy sectors.

Economic and Political Consequences We can expect that there will be important consequences of any major technological shift in an important sector of the economy, especially if it contributes to under-structures of other industries such as the energy sector. The most important results of the latest technological developments in the fracking and multidimensional drilling techniques can be pin down as economic, political and geopolitical. As for economic perspective, first of all, a huge economic potential has been revealed. It has already changed the macroeconomic calculations and predictions for USA economy. Just it was struggling the aftermath difficulties of the 2008 crisis, intellectual climate changed now calling to prepare itself to the next economic boom. This might continue in other geographies of the globe as the world's resources are being re-evaluated; and also the updates in the prediction of the future of the world's biggest economy will change the predictions and near future plans of the other economies.

Another important economic change has come in terms of a change in comparatives in the energy economics. It is well known the reason that why hydrocarbons are being used as primary resource is their comparative cost advantage (Figure 5). The stimulus and investment budgets for alternative energy production have been based on mainly the idea of imminent scarcity of the fossil fuels as well as their adverse effects on environment primarily as carbon emissions. Therefore, any change in this perspective will change the projection on the spectrum once again.

Total Levelized Cost (¢/Kilowatt-Hour) Figure 5. Total Levelized Cost by Energy Source: EIA, 2011 As the determination of energy spectrum is based on national and central decisions, the new projections on the primary energy resources will change the all plans and projections on the other energy tools. Because energy constitutes the main input of the manufacturing and transportation sectors, a change in energy macro-policies will also affect the investment decisions of these industries.

Another important effect can be classified as geopolitical change. The shale gas shift has not been obviously affect the other part of the world but even the changes have been happening (as well as the one being projected) are enough to lead unprecedented changes in the international relations. America's imminent takeover the lead position in the energy production will make the continent energy independent. The shift of the world's biggest economy into the energy independent position means also a shift to political and geopolitical independencies because the relations of energy supply have been thought as the main factor in the geopolitics and international dependencies.

Conclusion Some of the technological developments are brought together to shape this unconventional gas production boom we have been experiencing lately. The biggest effects so far have been in US energy production and US economy which was the start-off point itself; and it seems to continue growing. The predictions about the size of new potential vary from a capacity enough for few decades' consumption to one enough for more than century's annual energy consumption of US. It apparently implies that a big change is imminent in a lot of area starting from the energy economics and comparatives to energy politics and geopolitics.

The wide range of the projections about its possible effects will be clearer with coming information. However, the situation especially in US seems the action speaks first, production numbers rise and the predictions come later following the new numbers and discovered potentials. In this situation, a possible

cost-benefit evaluation for the other producers and potential investors stays ambiguous and not feasible forcing them to a waiting position in the reshaping market.

There is bigger uncertainty about the direct and indirect results of this new imminent boom on the other part of the globe. In this aspect, we can evaluate that the biggest effects will be on the Middle East and Central Asia that include the other main oil and gas producers.

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