Meynkhard, Artur

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Energy Efficient Development Model for Regions of the Russian Federation: Evidence of Crypto Mining

Artur Meynkhard*

Department of financial markets and banks, Financial University under the Government of the Russian Federation, Moscow, Russia. *E-mail: meynkhard@yandex.ru

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ABSTRACT

Paper proposes a model of energy efficient development of the regional energy complex, in which provided by mixing and iterative matching forecasts of energy consumption and energy production. The novelty of this method is that it formed in the framework of the regional model, is part of the overall regional product-sector balance formed for the region, which allows to simulate the mutual influence of energy complex and the rest of the economy through interbalance relations. Search for optimal solutions are carried out by iteration using a specially designed approach based on the Stiglitz-Sen-Fitoussi approach. It includes the following welfare components: Economic well-being, non-monetary characteristic welfare and reproduction potential of the economy. System of crypto mining based on the evidence of proof-of-work protocol are extremely no energy efficient. Paper also gives evidence of Russian regions for mining of cryptocurrencies in Russia.

Keywords: Energy, Resource Saving, Energy Efficient Development, Energy Indicators, Forecasting
JEL Classifications: C30, D12, Q41, Q48

1. INTRODUCTION

Economic development must be energy efficient. At present time, this thesis is becoming more relevant, including in the regions, that confirmed by the keen demand for information technology, which would allow regional authorities to form accountable and projected fuel and energy balances, based on their estimates energy efficiency and energy security of the regional economy, including the energy intensity to make scientifically based forecasts of the consequences accepted decision-making to form balanced systems of targets for energy efficient development region and assess their reachability.

Cryptocurrency is a kind of digital money based on cryptography technology, that is, data encryption. It does not have a physical appearance, and exists only in electronic form. Its main features are anonymity, decentralization and security.

Bitcoin is a peer-to-peer payment system that uses a unit of the same name to account for transactions and a data transfer protocol of the same name.

The literature describes a large number of support systems management decisions in the energy sector - from systems whose scope limited to managing individual energy carriers, to complex systems that view the power industry as a whole as an integral part economy (Gillingham and Palmer, 2014; Mikhaylov, 2018b; Branch, 1993).

Theoretical and empirical problems that arise when creating systems of models of energy economy used for short and medium term forecasting (Baker et al., 1989; Mikhaylov et al., 2018).

The most important component of any support system management decisions in the energy sector is a model of energy complex and its links with the rest of the economy (Mikhaylov, 2018a).

We reviewed more than 250 energy models widely used in different countries for the purpose of analyzing and forecasting energy development (Balestra and Nerlove, 1966; Davis, 2008; Davis, 2011).

However, the greatest pragmatic interest are Russian research in the field of energy modeling and forecasting, since they more take into account the peculiarities of national institutions management and statistical description of the objects of modeling (Blanchard, 1983).

This technology has been used for many years to predict Russian energy. The main feature of this technology is the formation consistent and mutually agreed system of forecasting volumes energy consumption by the economy and production volumes (Cameron, 1985; Gerarden et al., 2015).

The main types of fuel and energy in the fuel and energy sector. There is no regional level at the moment, but foreign ones developments do not take into account the important features of the Russian regional energy and do not have adequate information in the necessary detail (Halvorsen, 1978; Gillingham et al., 2012).

The purpose of this study was to develop methods, models and information technology to support decision making of regional authorities in the tasks of increasing energy efficiency and energy security of the regional economy (Mikhaylov, 2019; Halvorsen and Larsen, 2001; Gillingham et al., 2009).

Developed methods and information technologies are designed as predictive and analytical models aimed at forecasting and strategic planning energy-efficient development of the region (Nyangarika et al., 2019a; Nyangarika et al., 2019b).

2. METHODS

The task of energy-efficient development of the region comes down to searching agreed scenarios for the development of the fuel and energy complex and the region's economy, under which the maximum approximation of regional development indicators to objectives that characterize the development of the regional economy as energy efficient in terms of efficiency of production processes, conversion, distribution and final consumption of all types of fuel and energy resources.

Then indicators of regional development are below:

$$Et = [Eener(t), Eecon(t)]^T \quad (1)$$

where *Eecon* - vector of indicators characterizing socio-economic development of the region (the level of welfare of the population and the potential of a regional economics), and *Eener* - vector of energy indicators characterizing development regional economy in terms of energy efficiency.

Then

$E^0t = [E^0ener(t), E^0econ(t)]^T$ - vector of target values set for development indicators on the horizon of strategizing $[0, t_T]$.

Formally, the task of energy-efficient development of the region (subject of the Russian Federation) can be reduced to the following problem of multicriteria optimization:

$$\|Et - E^0t\| \rightarrow \min; \text{ where } t = t1, t2, \ldots tT \quad (2)$$

$$E(U,t) = ME\,(R,U,t) \quad (3)$$

$$dR(t)/dt = MR\,(R,U,t)$$

Observation model allowing to count estimates of indicator values *tE* for a development scenario regional economy and fuel and energy complex:

$$U(t) = Uecon\,(t), UFEC\,(t),\ U(t) \subset DU \quad (4)$$

Where:

Uecon (*t*) - vector of scenario parameters of regional development economy; *UFEC* (*t*) - vector of scenario parameters for the development of the fuel and energy complex;

DU - space of management decisions; *R* = [*r*1, *r*2., *rm*] - vector of regional resources;

MR (*R*,*U*,*t*) - model of the region; *DR* (*U*,*t*) - resource constraints.

3. RESULTS

3.1. Regions Efficiency

Solution of the problem (1)-(4) largely depends on the chosen system of indicators and targets for them who must answer to the question which economic development is viewed as energy efficient in terms of efficiency of production processes, conversion, distribution and final consumption of fuel and energy resources.

With forming a system of economic indicators authors relied on the proposals of the Stiglitz-Sen-Fitoussi commission, in which distinguish the following welfare components: Material living conditions (economic well-being), quality of life (non-monetary characteristic welfare) and the reproduction potential of the economy.

When forming a system of energy indicators Eener by authors used legal documents defining concepts "Energy intensity," "Energy efficiency," "Energy security" and "Energy saving," as well as materials European Commission on Energy.

When selecting energy indicators the requirements of completeness, consistency, and statistical measurability of indicators, that is, used indicators calculated by regional statistics.

Since the fuel and energy complex of the region is closely connected with other sectors of the economy and sides of society, the fuel and energy complex model was developed as part of a model socio-economic activities of the region as a whole. Based on the model subject of the Russian Federation, developed by the authors in the class of CGE-models (Brown, 2001; Hanemann, 1984; Feng et al., 2013).

The basis of energy complex models have a regional fuel and energy balance, connecting together the processes of production, transformation and final consumption of all types of fuel and energy resources used in the region. We used the official methodology for compiling regions of the Russian Federation (Ministry of Energy of the Russian Federation (DeCanio, 1998; Dubin and McFadden, 1984; Nyangarika et al., 2018) and the Russian Federation (Federal Service statistics. Order of April 4, 2014 N 229), as well as the recommendations of the IEA and Eurostat (Key World Energy STATISTICS, 2014; Energy balances of non-OECD countries, 2015).

We introduce the criterion Φ, which characterizes the total relative indicator vector deviation.

$$\phi(U,t)=\left\{\sum_{i=1}^{N}\left\{g_i\sum_{k=1}^{T}\left|\frac{e_i(U(t_k))}{e_i^0(t_k)}-1\right|\right\}\right\} \tag{5}$$

Where

N - total number of indicators (economic and energy);

g_i - significance (weight) of the i-th indicator;

T - number of points in the strategy interval.

The task of finding an energy efficient development option will be reduced to next optimization problem: Find a valid development scenario of the economy the region and energy complex.

$$\min_{U(t\subset D_U)}\phi(U(t))=\min_{U(t\subset D_U)}\left\{\sum_{i=1}^{N}\left\{g_i\sum_{k=1}^{T}\left|\frac{e_i(U(t_k))}{e_i^0(t_k)}-1\right|\right\}\right\} \tag{6}$$

It was been calculated on region models for solving the direct problem of scenario forecasting (4) for the development scenario.

The effective matrix method is proposed for solving problem (6) for many tens of goals (N), hundreds of control variables and deep forecast horizons (T). Designed based on the matrix method the solver automatically generates development scenarios in which the values indicators Et as close as possible to the goals.

3.2. Evidence of Bitcoin Mining

Cryptocurrency is a kind of digital money based on cryptography technology, that is, data encryption. It does not have a physical appearance, and exists only in electronic form. Its main features are anonymity, decentralization and security.

Bitcoin is a peer-to-peer payment system that uses a unit of the same name to account for transactions and a data transfer protocol of the same name. Mining is a process that solves various computational problems during which bitcoins are created (Table 1).

Mining can be done on a home computer, subject to the availability of a powerful GPU - a video card, and on special equipment.

However, mining requires a significant amount of electricity, including for cooling processors.

Kuwait is on the 1st place in the list of countries with cheap electricity tariffs - 1.00 cents/kW. Saudi Arabia ranks second in terms of cheapness - 1.30 cents/kW. Three leaders closes Venezuela - 3.1 cents/kW.

Table 1: Bitcoin network statistics

Description	Value
Bitcoin's current estimated annual electricity consumption* (TWh)	47.73
Bitcoin's current minimum annual electricity consumption** (TWh)	45.94
Annualized global mining revenues, USD	2,706,505,667
Annualized estimated global mining costs, USD	2,386,362,512
Current cost percentage	88.17%
Country closest to Bitcoin in terms of electricity consumption	Singapore
Estimated electricity used over the previous day (KWh)	130,759,590
Implied Watts per GH/s	0.113
Total Network Hashrate in PH/s (1,000,000 GH/s)	48,124
Electricity consumed per transaction (KWh)	405
Number of U.S. households that could be powered by Bitcoin	4,419,190
Number of U.S. households powered for 1 day by the electricity consumed for a single transaction	13.68
Bitcoin's electricity consumption as a percentage of the world's electricity consumption	0.21%
Annual carbon footprint (kg of CO_2)	23,386
Carbon footprint per transaction (kg of CO_2)	198.33

Source: www.coinmarketcap.com, Thomson reuters, calculated by the author

And, for example, Japan, Finland, Britain, Switzerland, Portugal, Singapore, Hungary, Ireland, Italy pay from 20 to 30 cents/1 kWh, Germany and Denmark - up to 40 cents. Russia in the ranking of countries with the cheapest electricity is on the 13th place (Figures 1-3).

However, the place of the rural part of the Baikal region in this list, if it participated in the rating, would compete with Saudi Arabia.

According to the data as of July 1, 2017, the cheapest electricity in the Irkutsk region is 1.01 rubles/kWh. Since the Irkutsk region has the cheapest electricity, the Irkutsk people can afford to work around the clock equipment.

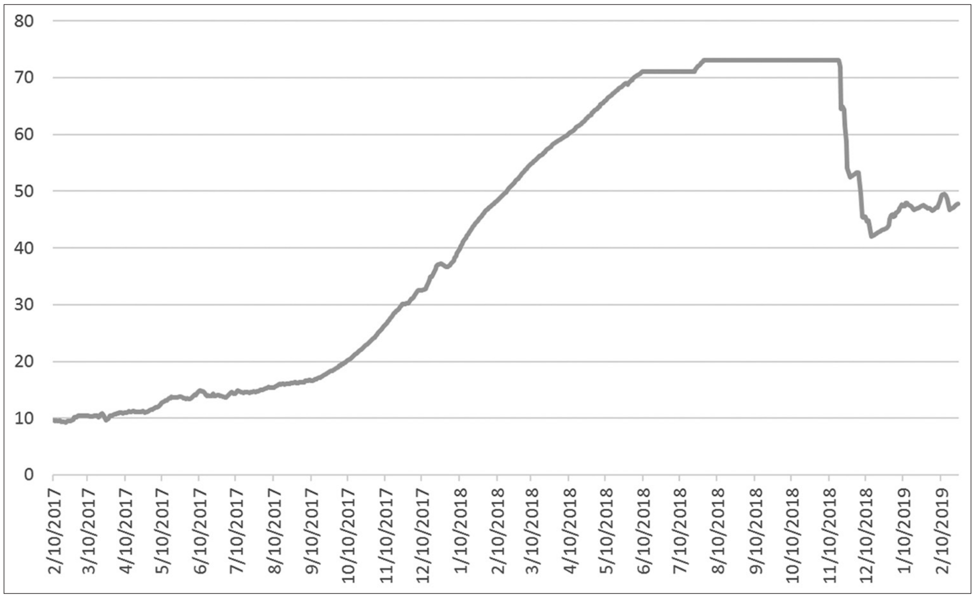
That is why here mining of bitcoins is becoming more and more popular, and the efficiency of generating bitcoins is the highest in the world. That's just all the owners of miners - both homemade and factory - faced with the fact that their equipment is very hot and quite noisy or buzzing.

Often the working temperature exceeds 50 degrees and the fans, which remove heat from the working parts, are noisy. On one miner you need, on average, 2 kW. For one private home ownership stands 15 kW. 5 kW is enough to meet the needs of home appliances and lighting.

And it is possible to pick up 10 kW for the work of cryptoboiler, and provide heat for heating the house and pay for consumed electricity.

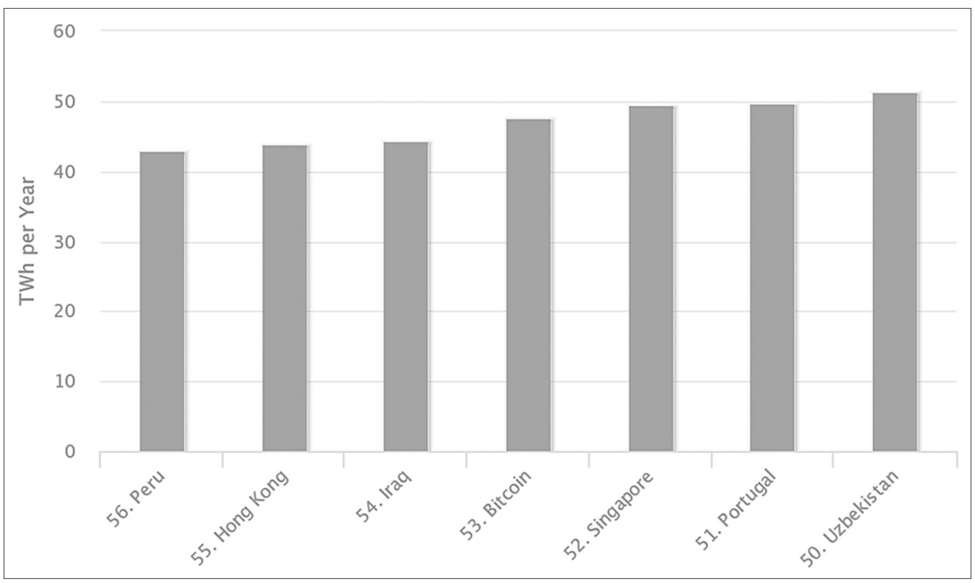
A cryptoboiler is operating on the basis of one miner can heat, on average, 14 square meters of living space. The enterprising

Figure 1: Bitcoin energy consumption, TWh per year



Source: www.coinmarketcap.com, Thomson Reuters

Figure 2: Comparison with country energy consumption



Source: www.coinmarketcap.com, Thomson Reuters

residents of Irkutsk have come up with how a mining farm can be connected to the "warm floor" so that heat is not wasted into the atmosphere and warms the house.

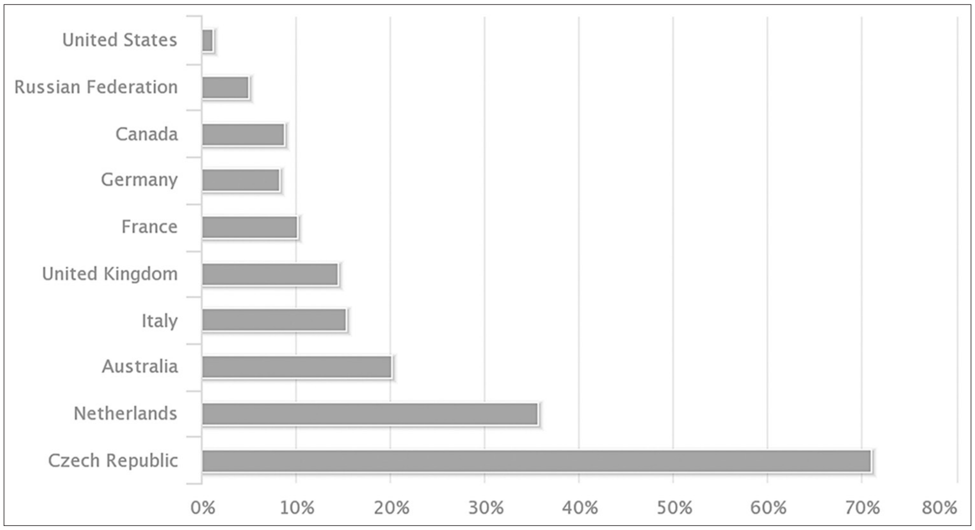
Despite the attractiveness of the Irkutsk region for mining, the Russian blockchain and cryptocurrency association conducted a study to determine the 59 most favorable region for mining cryptocurrencies in Russia, and it turned out to be Krasnoyarsk Region. Moreover, electricity tariffs are not the lowest here - 2.37 rubles/kWh. However, the attractiveness of Krasnoyarsk for mining primarily lies in the logistic and telecommunication capabilities of this region. Despite the favorable conditions, almost no one is engaged in mining in the Krasnoyarsk Territory.

4. CONCLUSION

The author has developed an information technology forecasting balanced development of the economy and the fuel and energy complex, in which provided by mixing and iterative matching forecasts of energy consumption and energy production.

The novelty of this method is that it formed in the framework of the regional model, is part of the overall regional product-sector balance formed for the region as a whole and playing the role of "balance sheet," which allows through interbalance relations to simulate the mutual influence of the fuel and energy complex and the rest of the economy. Search for optimal solutions are carried out by iteration using a specially designed solver.

Figure 3: Comparison bitcoin energy consumption to some of the energy consuming nations



Source: www.coinmarketcap.com, Thomson Reuters

The developed technology has been tested in forecasting development of the Samara region on the scenarios of the Energy Strategy of Russia on period up to 2035, adapted for the subject of the Russian Federation.

Strategic planning of energy-efficient development of a constituent entity of the Russian Federation reduced to finding consistent scenarios for the development of the fuel and energy complex and the region's economy, at which the maximum approximation to the target settings for proposed system of economic and energy indicators.

Crypto mining can develop energy efficiency in several regions. In contrast, the mining farms in Russia are located in Moscow, St. Petersburg, Novosibirsk, Irkutsk, Sverdlovsk, Tomsk, Chelyabinsk and Tatarstan. In general, the recent cryptocurrency phenomenon, but the excitement around cryptocurrency captured not only our country, but the whole world, and logically led to an increase in the rate of Bitcoin.

Cryptocurrency is still in the gray zone of the Russian economy, but it does not stop those who want to make a fortune.

According to some information, large corporations are already striving for cryptocurrency in the investment market. True, they do it carefully and secretly.

Dynamic leaps attract the attention of financiers, but currency magnates do not harbor any major illusions. In the entire history of the exchange coups there have been cases and profitable.

It is not known how the popularity of cryptocurrency will affect the cash additions of investors.

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