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RUSSIAN ENERGY EFFICIENCY

Can Extraction Tax Policy Improve Energy Intensity?

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ABSTRACT

Sustainable development, renewable energy, climate change, emissions reductions and energy efficiency are dominant topics in the world today. Policy makers are continually forced to make tough decisions in addressing these topics and more often one can see a trend in policies that defy basic market principles. Some examples are increased regulations, Pigouvian taxes, direct government funding of renewable energy projects, and carbon trading schemes. However, many of these policy decisions run in stark contrast to market forces and can subsequently damage economic growth. Additionally, many of these policies attack the fossil fuel industries that drive the global economy***. In what ways can we use the invisible hand of the market to improve the world we live in while gaining economic prosperity in the process?*** I continue to search for mechanisms and policy tools that can help to achieve goals in these critical areas by working with market forces in the energy sphere instead of against them. This paper is written with that goal in mind.

The paper examines whether extraction tax policy in the oil and gas industry in the Russian Federation is a possible instrument in improving overall Russian energy efficiency. The article gives an overview and analysis of how energy efficiency is measured at the macro and micro level using indicators such as Energy Intensity and Energy Return on Energy Invested in order to determine the energy efficiency of oil and gas extraction. It explores the Russian tax system as applicable to the oil and gas industry, changes within the system, and their potential impact. Lastly it evaluates the results of some tax policy changes on Russian oil production specifically in older, Soviet Legacy fields often referred to as Brownfields. The conclusions of this paper show that a more flexible extraction tax policy will contribute to Russia's overall energy efficiency improvements by increasing GDP through energy efficient oil and gas production.

Key Words: *Energy Efficiency, Energy Intensity, ERoEI, Mineral Extraction Tax, Russian Oil and Gas Production, Brownfields, Oil and Gas Tax Policy*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Bbl – Barrel (usually of oil)
Bcf – Billion cubic feet
Bcm – billion cubic meters
Brent – Brent Crude Oil Market Price
Btoe – Billion tons of oil equivalent
Btu – British Thermal Units
EE – Energy Efficiency
EEU – Eurasian Economic Union
EI – Energy Intensity (Toe/Unit of GDP)
EIA – United States Energy Information Agency
EOR – Enhanced Oil Recovery
ERoEI – Energy Return on Energy Invested (usually expressed as a ratio eg. 10:1)
ESPO – Eastern Siberian Pipeline
GDP – Gross Domestic Product
IEA – International Energy Agency
Kcal – Kilocalories/Caloric Value
KPI – Key Performance Indicators
Kw – Kilowatts
LCU – Local Currency Units
MET – Mineral Extraction Tax
Mj – Megajoules
Mtoe – Million tons of oil equivalent
MW – Megawatts
NER – Net energy gained (ERoEI-1)
ORF – Oil Recovery Factor
POS – The Power of Siberia Pipeline
PPP – Purchase Power Parity
ROI – Return on Investment
RF – The Russian Federation
Tcm – Trillion cubic meters
Toe – Tons of oil equivalent
U.S. – The United States of America
USD – United States Dollars
Urals – Urals Grade Crude Oil Market Price
VAT – Value Added Tax
WTI – West Texas Intermediate Crude Oil Market Price

INTRODUCTION

Energy efficiency is commonly referred to as the hidden energy because it is often underappreciated and correspondingly under-utilized. Despite the obvious benefits of improving efficiency in energy use and the subsequent savings of natural resources, many policy makers struggle with implementing strategies and policies designed to maximize energy use through efficiency. Russia is not an exception and may be the biggest of all developed countries in need of promoting and implementing energy efficient policies. The 2014 Global and Russian Energy Outlook to 2040 states:

Low energy efficiency is the Achilles heel of the Russian economy, not so much because of the cold climate, but because of the country's excessive focus on raw materials and outdated technology in the fuel and energy sphere; it seems that it will not be possible to fully resolve this problem in the next 25 years (Energy Research Institute and Russian Academy of Sciences 2014).

The Russian Federation by all accounts is the world's energy export powerhouse. With energy production of over 1.3 billion tons of oil equivalent (Toe) in 2015 and exports exceeding 600 million Toe, it is the leader in world energy representing 10 percent of global production and will continue to hold a large share through 2040. Unfortunately, it is the 6th largest consumer and disproportionally uses 5.5 percent of the global total in that, with a population of close to 150 million (less than 1% of the global population) Russia is using far more energy per capita. Additionally, its energy intensity is almost twice that of the global average (Energy Research Institute and Russian Academy of Sciences 2014).

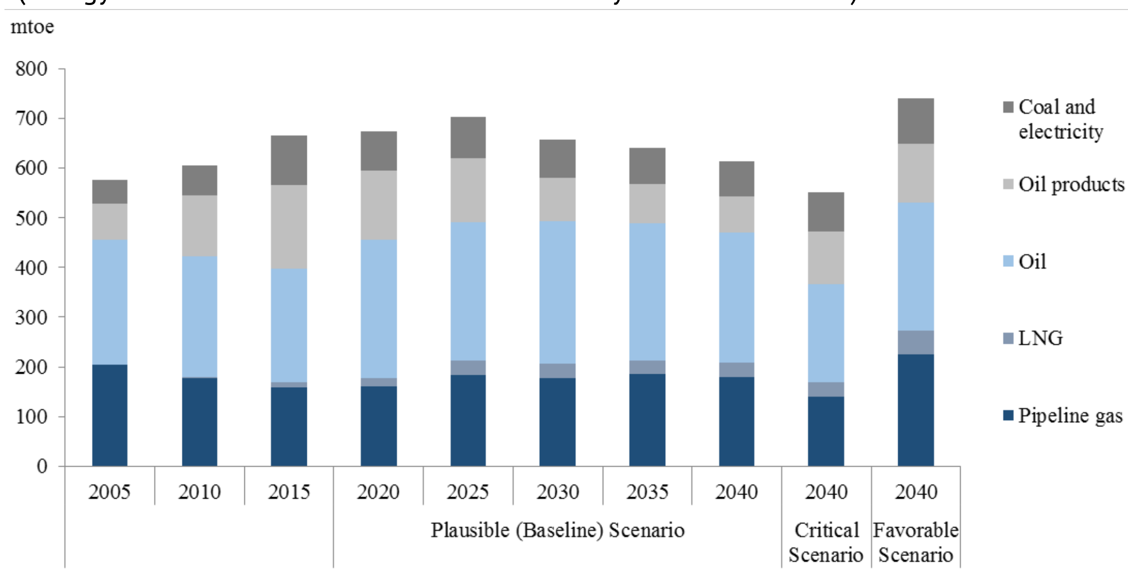


Figure 1 – Russian Energy Exports

Source: ERI RAS, ACRF. Global and Russian Energy Outlook Up to 2014. 2016. P.148.

Disappointingly, one of the most significant problems with energy efficiency programs is that they don't always align well with market efficiency. One of the best Russian examples of this phenomenon and noted by Russian energy leaders is that the largest gas reserves in the country are named Moscow and St. Petersburg in semi-humorous reference to the level of inefficiency in domestic energy usage, specifically in relation to natural gas. The existence of cheap gas has created a disincentive for both consumers and producers to implement energy savings and/or energy efficiency measures. This failure of market mechanisms demonstrates a need to examine potential tax policy reforms that may assist in improving Russian energy efficiency.

One of the most common policy responses for many governments has been to institute Pigouvian style taxes in order to influence consumer behavior in energy usage. However, this is usually done in countries that are net importers of fossil fuels. Therefore, there may be better alternative policy measures in terms of taxes that might be applied in the Russian Federation to reach their energy efficiency targets. Specifically, is the Russian Federations tax policy on resource production actually harming the market process by stagnating production with prohibitive taxes such as the Mineral Extraction Tax? One way this paper addresses that issue is to focus solely on existing oil fields, commonly referred to as "brownfields", which have declined in production over the last several years, but not because they are depleted. Since these fields have available resources and infrastructure to support extraction they serve as a good way to understand what, if any, impact tax policy has on their output.

Currently, the Russian Federation uses the Energy Intensity method for measuring its energy efficiency – a measurement using MTOE/GDP (Million Tons Oil Equivalent/Gross Domestic Product) – it stands to reason that any significant increase in GDP without an equal increase of energy usage would create a net benefit in overall energy efficiency. Russia's main source of GDP is in the energy resource sector, primarily oil and gas and would therefore be using their strength to improve Energy Intensity instead of moving away from energy resources. This study walks through the logical process for determining if there is sufficient evidence to support such an approach beginning with an understanding of the tools for measuring energy efficiency, providing evidence that resource extraction, especially with oil, is energy efficient in itself, exploring the Russian resource taxation system and its impact, and finally examining oil production data following taxation changes.

Consequently, it is essential in understanding the way in which we measure energy efficiency and the factors involved in assessing relative improvements. In Chapter 1, I explain the distinct differences between energy efficiency (EE) and energy intensity (EI). Both are widely used tools for measurement in gauging a country's improvements, or lack thereof, in overall energy efficiency. Evaluating the positives and negatives of these approaches through a literature review will allow the paper to go further in reaching conclusions. This chapter also serves to educate the reader on the complexities of the sphere of energy efficiency.

For the second chapter we are only concerned that the production of oil in the Russian Federation, most specifically in brownfields, demonstrates an ability to be energy efficient by the energy intensity method covered in the first chapter. With a lack of specific sector data in the Russian Federation on energy intensity of oil extraction, I utilize another method of measuring energy efficiency called Energy Return on Energy Investment (ERoEI). Before any further examination takes place within this study, it is necessary to establish that oil extraction is indeed energy efficient on its own or it would, by default, hurt the overall energy intensity of the Russian Federation. It stands to reason that since energy intensity is the measurement of the number of units of energy for each unit of GDP, that if we can establish a workable efficiency number for Russian brownfields, we can extrapolate that number into calculating the effects of increased production on overall energy intensity. For this reason, we will look at established ERoEI estimates of other production areas in Russia and from around the world and some data from various Russian sources to ascertain a reasonable working ratio concerning ERoEI.

The third chapter will review the existing Mineral Extraction Tax (MET) structure in the Russian Federation as well as other tax mechanisms utilized by the Russian Federation in its resource management. It serves primarily to show the reader how these mechanisms are designed to work and evaluate literature on energy resource taxes. My research is focused on determining if adjustable rates in the MET might serve as a successful mechanism for improving Russian energy efficiency by increasing resource extraction and economic growth without directly taxing consumers. Essentially, this chapter directly addresses the theoretical answer to our question, “can a change in the MET regime achieve these aims since it plays to Russia’s strengths as an energy exporter?”

Chapter four further explores how similar tax policies have been applied to existing “brownfields” in Russia. Fortunately, the Russian government has already seen fit to lower the coefficients in the mineral extraction tax calculations on oil and gas extraction in many areas such as Tatarstan and Western Siberian “brownfields” in order to promote more production. This chapter evaluates some of the early results in the last few years and the impact they are having on production. Additionally, this chapter evaluates other factors affecting resource extraction efficiency and increases in production. It reviews examples of the effect of tax policy on declining fields to see if there are any correlations between these changes and energy efficiency improvements.

In chapter five I present some projections of potential economic growth for the Russian Federation if resource usage and production were enhanced. Our model is based on three different price ranges for global oil prices and I make estimates based on current and potential production increases. I then extrapolate the projections for production growth and their relative impact on the Energy Intensity figures for the Russian Federation. In this chapter I assess the contribution of production in declining fields on Russia’s GDP and attempt to evaluate to what degree increased production from these fields affects energy intensity at the macro level. Of course, this is the trickiest section as Russia is currently experiencing negative growth, but the section provides some clues on potential and leads to my conclusions in the final chapter.

CHAPTER 1. MEASURING RUSSIA'S ENERGY EFFICIENCY

IS ENERGY INTENSITY THE BEST METHOD IN EVALUATING POLICIES AND STRATEGIES?

It is a stated goal to improve upon the efficiency of Russian energy usage and lower its energy intensity by 2% annually over the next 25 years (Energy Research Institute and Russian Academy of Sciences 2014). Russian policy makers led by former President Medvedev and current President Vladimir Putin have outlined several sets of goals for Russia in the area of energy efficiency and many policies have been implemented with some initial success such as the gradual liberalization of domestic gas markets. For the purposes of this section we will make some assumptions regarding the goals of Russian energy strategies and policies based on what has been publicly stated by officials in the various government ministries and by the leaders of Russia's largest energy companies.

Consequently, it is necessary to determine if the tracking of "energy intensity" is the best course of action for the Russian Federation in accomplishing the goals by evaluating the pros and cons of "energy intensity" as a tool. Therefore, I assume that the goal is to improve energy efficiency while also achieving the following:

- Allowing for increased revenues from natural resources;
- Increasing tax revenues and stimulating growth;
- Diversifying the balance of GDP;
- Increasing available capital (foreign and domestic);
- Increasing Disposable Incomes.

One of the key components to achieving these goals is deciding on the methodology used in measuring the progress of energy efficiency programs effectively.

To illustrate the massive opportunities for the Russian Federation in the area of energy efficiency and to encourage policy and strategy changes, the International Finance Corporation conducted a study in 2008 titled Energy Efficiency in Russia: Untapped Reserves. The study, while several years old now, demonstrated a plethora of net benefits available to Russia if it were to undertake a serious shift towards improving energy efficiency. The recommendations and estimated results suggested an investment of $320 billion (USD) but with a sizable return. Conservative estimates of the annual savings included 240 billion cubic meters (bcm) of natural gas, 340 billion kilowatt hours of electricity, 89 million tons of coal, and 43 million tons of crude oil through petroleum products. This adds up to an annual $80 billion (USD) in direct savings and $40-70 billion (USD) a year in additional revenue from gas exports (International Finance Corporation 2008). The plan would essentially pay for itself within 5 years from the direct savings alone.

THE IMPORTANCE OF METHODOLOGY

Measuring energy efficiency is a complex process and can vary greatly depending on the specific area targeted for improvements. The Energy Information Administration (U.S.) has stated that the single biggest threat to implementing and managing energy efficiency projects is the ambiguity involved with measuring results (U.S. Department of Energy Industrial Technologies Program 2006). This has translated into a lackluster effort on the part of consumers, producers, and policy makers in making efficiency a priority. There are often conflicting goals between the three which creates a disincentive for proper implementation and reporting on the part of one or all of the actors involved. Market efficiency and energy efficiency are often not complimentary and in many cases are in direct conflict. Producers are not seeking ways to lower demand for their products for the benefit of conservation efforts and this can lead to poor implementation or reporting. Even in the U.S., which has fairly good institutions for measurement and track, there has been a large disparity between projected and realized results and the processes by which improvements (if any) are measured (Normandeau 2015). Consequently, in determining the best methodology for the Russian Federation with, by comparison, its institutional challenges are of paramount importance to choose an appropriate form of measurement (Deloitte 2015).

There are nearly as many ways to measure energy efficiency as there are ways to improve it. In the United States where many energy efficiency policies are implemented at the state level, the use of site energy measurement is common at the micro level, but also the use of the "market basket" approach, comprehensive, and energy intensity are common at the macro level. For every method, there are critics accompanied by a list of pros and cons. This problem is not unique to the U.S., and the European Union has had similar problems. There is no "one size fits all" method to measuring efficiency improvements, and according to the International Energy Agency the chosen method should be based on the goals, levels of development, and structure of each country (International Energy Agency 2015).

First, it is best to clarify exactly what the differences are between energy intensity and energy efficiency as they are often confused.

> ***Energy efficiency*** *improves when a given level of service is provided with reduced amounts of energy inputs or services are enhanced for a given amount of energy input.*
>
> *Whereas,* ***energy intensity*** *is measured by the quantity of energy required per unit output or activity so that using less energy to produce a product reduces the intensity* (International Energy Agency 2005).

Unfornately, the IEA is not clear here and these definitions appear to express almost the same thing. Instead, it is best to explain the difference as an inverse relationship between the two. For instance, if it takes 1 unit of energy to produce an automobile, but through energy efficiency measures the same level of energy produces 2 automobiles it is energy efficiency. Conversely, reducing energy intensity is done in the same manner by lowering the amount of energy to produce 1 automobile. This appears to be the same result and the same measurement at the micro level; however, it becomes more ambiguous as one tries to measure efficiency improvements across many different sectors of energy usage such as different types of manufacturing, residential energy usage, commercial, and transportation. Therefore, on an aggregate level, energy intensity can be represented by the total units of energy used divided by Gross Domestic Product. Typically, energy intensity is measured by million tons of oil equivalent divided by GDP (Mtoe/GDP in USD), but a simplistic method would be energy/GDP (U.S. Department of Energy 2012). The U.S. Department of Energy further states:

> *The distinction between energy intensity and energy efficiency is important when multiple technologies or multiple products underlie what is being compared. While it would not be sensible to compare the energy efficiency of steel production with the energy efficiency of ethanol production, it is possible to examine the energy intensity of all manufacturing (U.S. Department of Energy 2012).*

One of the most common, but misleading examples of how energy intensity can be improved (lowered) is by fuel type substitution such as the use of renewables, which have no measureable value for energy input since they generate electricity without a fossil fuel component. While this may have a positive impact on the environment and certainly on the cost dynamics of production, it changes nothing in regards to energy intensity or efficiency. For instance, if a manufacturer uses 1 Megajoule of electricrity to produce something it matters not how that energy is created. The manufacturer still produces the same output using the same energy input. Furthermore, in the case of the Russian Federation, there are no significant plans to increase the use of wind, photovoltaic solar or additional renewables. The estimated share of renewables by 2040 is only 3% of the projected Russian energy mix (Energy Research Institute and Russian Academy of Sciences 2014). Conversely, the substitution of gas for coal provides a model example, according to the IEA, in the reduction of energy intensity as shown in the following two charts from the IEA Energy Statistics Manual. The substitution of a 1/2 kg equivalent of natural gas for a full kg of anthracite coal will generate more Megajoules but with less input. In this scenario, not only is there lower energy intensity, but also an increase in productivity/efficiency. Using gas over coal provides almost twice the calorific value. The improved calorific value of burning gas also produces less carbon dioxide contributing to GHG reduction goals and other positive externalities, but usually at an increased cost (International Energy Agency 2005). Again, on the surface this appears to be an improvement in energy efficiency and intensity, but only in the manufacture of electricity and not for industry that relies on purchasing electricity. If the same amount of electricity is required to produce the same amount of output, then there is no improvement in intensity or efficiency. However, if one were evaluating sources for the generation of electricity, fuel substitution such as gas for coal would appear to be a solid option. The merits of this are not a discussion point for this article. Rather I want to point out the various ways in which we measure efficiency and intensity.

Table 1 – Range of Calorific Values by Hard Coal Type

Hard coals	GCV (as used) MJ/kg	NCV (as used) MJ/kg	Carbon content (as used) kg/t	Moisture content (as used) %	Carbon content (dmmf)* kg/t
Anthracite	29.65 - 30.35	28.95 - 30.35	778 - 782	10 - 12	920 - 980
Coking coals	27.80 - 30.80	26.60 - 29.80	674 - 771	7 - 9	845 - 920
Other bituminous	23.85 - 26.75	22.60 - 25.50	590 - 657	13 - 18	810 - 845

Source: Energy Statistics Manual International Energy Agency 2005

Table 2 – Conversion Factors from Mass or Volume to Heat (Gross Calorific Value)

	LNG		GAS							
			Norway		Netherlands		Russia		Algeria	
To:	MJ	Btu	MT	Btu	MJ	Btu	MJ	Btu	MJ	Btu
From:	multiply by:									
Cubic metre*	40.00	37912	42.51	40290	35.40	33550	37.83	35855	39.17	37125
Kilo-gramme	54.40	51560	52.62	49870	45.19	45.19	42830	54.42	20.56	47920

* at 15°C.

Source: Energy Statistics Manual International Energy Agency 2005

Methodology is also important when making policy decisions because the accurate evaluation of such policies is essential in order to make adjustments, duplicate positive results, and abandon failures. This is particularly true when using paternalistic policies that are modeled using externalities and internalities when considering consumer behavior. If the measurement tool of such policies is not consistent it can make policy evaluation increasingly difficult and fail to identify a lack of intended market signals to consumers. In order for energy efficient policies to succeed consumers must choose to participate, but this is not likely if there are no obvious cost saving incentives. The creation and management of Pigouvian style taxes can be effective, but must be closely and accurately monitored or adversely affect markets. Such mistakes can lead to diminished sector growth especially in manufacturing and building (Whitman 2006).

There is an abundance of barriers to implementing energy efficiency programs that exist naturally already and the more complex the measurement tool the harder it is to overcome these hurdles. The International Institute for Applied Systems Analysis in its 2014 Global Energy Assessment listed a number of these obstacles in a thorough and comprehensive assessment of energy and the economy (International Institute for Applied Systems Analysis 2014).

- Low or underpriced energy undermine incentives to save energy.
- Regulatory Failures. Consumers that receive unmetered heat lack an incentive to adjust usage and therefore utility rate setting can hinder targets.
- Consumer preferences. Vehicle purchases are rarely made based on efficiency. Rather they are based on size, speed, and appearance.
- Lack of or misplaced incentives. Energy companies are not in the business of lowering energy demand.
- Higher upfront costs for energy efficient appliances. Consumers often expect a quick return on investment in energy saving goods.
- Financing barriers for energy efficiency projects. Building owners have little incentive to finance efficiency improvements for tenants that are responsible for utility costs.
- Lack of trained personnel in energy efficiency regulatory frameworks, their implementation and management.
- Availability of products in less developed countries or the lack of adaptability to better technologies.
- Limited consumer awareness. Firms have little knowledge of the benefits of improving efficiency or are unwilling to pay for audits to recommend improvements.

Although not all of these conditions necessarily apply to the Russian Federation, close monitoring of policies and their intentions and consequences cannot be stressed too much. Energy intensity measurements by sector can be extremely helpful in this process (Allcott 2014).

With a solid understanding of how energy intensity is measured and how it compares to energy efficiency it is necessary to evaluate whether it is the proper choice for Russian energy decision makers.

POTENTIAL DRAWBACKS TO USING ENERGY INTENSITY FOR RUSSIA

There are several potential issues with the energy intensity method in evaluating efficiency improvements. The method has been largely criticized in the U.S. and the EU for some of these failings. The key is determining if those drawbacks apply to the Russian Federation and if so, are they significant enough to choose another approach.

First, energy intensity can suffer from "structural" changes that do not indicate any improvement or deficiency in energy usage, but rather are affected by events or changes that lie outside the energy usage sphere. Some examples of this phenomenon are changes in climate and weather patterns that affect heating or cooling habits for businesses and residences. Also, large population movement in a country to different climate zones or the increased age of citizens on aggregate can lead to a change in usage patterns as older people tend to use more energy to heat and cool their homes.

Second, measurement of energy intensity on aggregate can be ambiguous because of changes in various energy using sectors such as industry and manufacturing. For instance, one of the most common criticisms of the U.S. decline of energy intensity is that it is not an indication of efficiency improvements, but rather an indication of the manufacturing base being moved offshore to less developed countries and sometimes as a direct result of energy efficiency regulations among other reasons. Therefore, these intensive industries are no longer contributing to the average. This is similar to complaints among "green" groups in Europe that many EU members are not truly improving efficiency, but rather moving polluters to non-regulated countries indicated by the flat global trend in energy intensity shown in the Figure 2. The following graph illustrates some of the movement and trends of energy intensity and usage per capita. Noticeably, China and India have lowered their energy intensity as well as the other major economies of the world, but the global level of energy intensity remains roughly the same (International Institute for Applied Systems Analysis 2014).

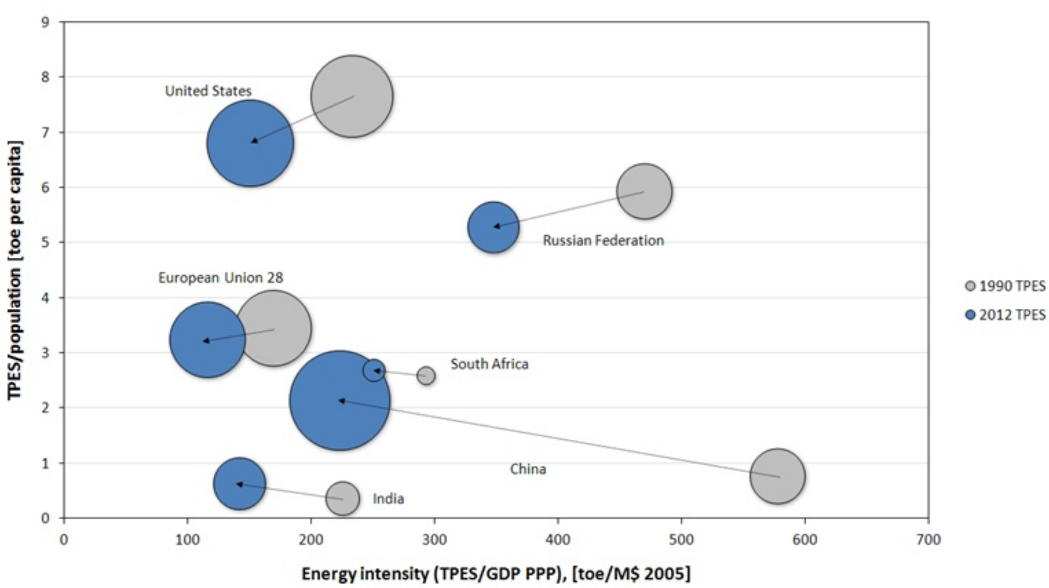


Figure 2 – Energy Intensity in Relation to Toe per Capita

Source: International Energy Agency Graphic 2014

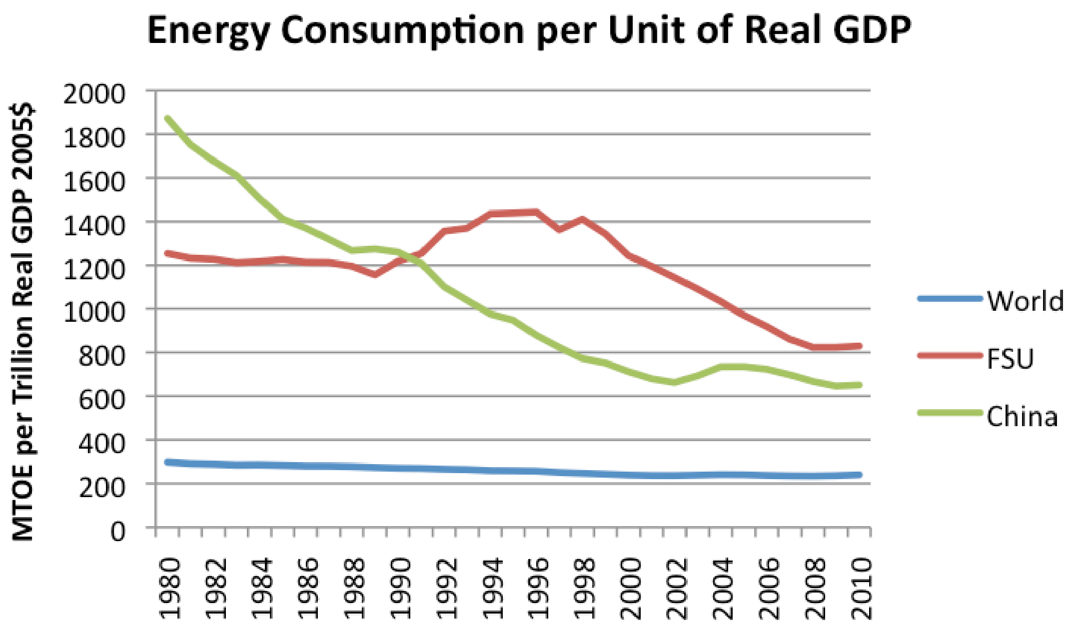


Figure 3 – Energy Consumption per Unit of Real GDP

Source: International Energy Agency Statistics

Additionally, energy intensity figures can also be distorted by energy prices. This can be particularly important in the case of the Russian Federation since a large portion of GDP is attributable to energy exports. A telling example of this is the tremendous reduction of energy intensity in Russia over the period from 1998 until 2014 where oil prices (and subsequently oil indexed gas prices) were at historic highs. Russian energy intensity declined by over 5% a year on average during this period while growth in GDP averaged around 7%. Unfortunately, this same period saw few, if any significant gains in efficiency technologies or policy implementation to justify such a decrease in intensity (Energy Research Institute and Russian Academy of Sciences 2014). With currently depressed oil prices, any large increase over the next several years would need to be accounted for in analyzing policy initiatives on the energy efficiency front.

Lastly, there is the issue with climate and its impact on energy use during extreme heat and cold. On the surface it might appear that this would have a significant effect on Russian domestic usage and therefore on energy intensity measurements. However, structural issues such as weather are of less concern for Russia as most of its climate is consistent and much of the country lies above the 55th parallel with permafrost. While this increases the need for heat sources, it does so consistently which will not adversely affect the energy intensity tracking. It does stand vulnerable to energy price increases distorting intensity numbers, but only if the prices surge due to shortages in supply or an unexplainable jump in demand, both of which seem unlikely in the next few years. In any event, any increase in price would provide benefits that would swiftly outweigh a loss in accurate energy efficiency measurements.

Benefits of Russian Strategy in Utilizing Energy Intensity as a Measurement

Although we discussed the various factors that might distort energy intensity measurement for the Russian Federation going forward, there are just as many (maybe more) components to the Russian energy usage situation that indicate a positive fit for ***energy intensity***.

The first amongst these is the convenience of using the energy intensity method. This method has been central in the evaluation, planning, and development stages of Russia's current energy efficiency strategies and a change in methodology may upset the apple cart in the efficiency arena. However, this alone is not justification for using energy intensity.

The most striking reason that the energy intensity method is best for Russia's energy efficiency improvement planning is because of Russia's unique situation as both an industrialized country and a net exporter of nearly all forms of energy. No other country can claim this advantage in the realm of energy and this enables Russia to utilize energy intensity as a measurement because many of the structural and transaction abnormalities that affect energy importers such as the U.S. and the EU don't apply. For instance, price fluctuations in oil and gas don't have the same impact on domestic production of other goods or consumer usage patterns because they are highly inelastic in general and prices remain fairly constant in Russia. Specifically, Russian consumers see less fluctuation in the price of gasoline (benzene), natural gas, and electricity despite fluctuations in world oil prices as demonstrated in Figure 4 and Figure 5.

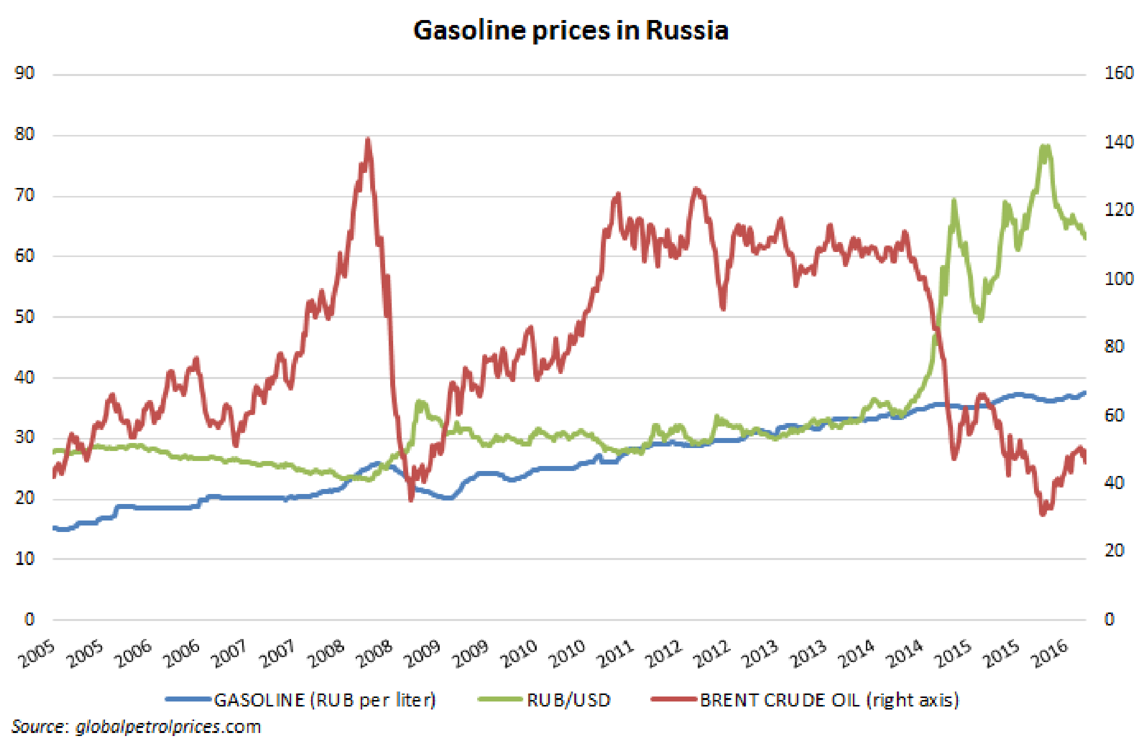


Figure 4 – Russian Gasoline Prices per Liter with exchange rate and Brent Crude Price

Figure 5 – U.S. Gasoline Prices per Gallon 2004 – 2015

Source: U.S. EIA

Russia's self-sufficiency helps to insulate it from global energy fluctuations allowing it to keep accurate measurements of its efficiency programs using the intensity model. An example of this insulation is that natural gas in Russia is traded according to tariffs and caps set by the government and natural gas is a significant contributor to the Russian energy mix.

Next, Russia's centralized government and top-down policy making would complicate micro-level assessment of energy efficiency measures and also expose measurement to institutional manipulation at the regional level where macro level targets are of considerably less concern. This reinforces the earlier discussion of the lack of sufficient institutional frameworks and personnel to implement and monitor programs of the micro variety (International Finance Corporation 2008). Instead, a broader national policy and strategy tool such as energy intensity is more appropriate. Also, the ministerial mix and culture (a slight holdover from the Soviet era) does allow for at least some if not a great deal of decoupling in evaluation of sectors such as industry, housing, and transportation. This will likely serve as a positive as the Russian Federation moves forward with its objectives.

Finally, Russia has a complex set of energy inputs of which few countries can match. Not only is Russia the most broad based energy exporter, it also has a broad range of energy inputs in the domestic mix. Although renewables as discussed earlier are not planned as a noteworthy contributor, Russia has an entrenched nuclear program with expansion plans, well developed hydro, and a mix of gas, coal, and fuel oil plants (Energy Research Institute and Russian Academy of Sciences 2014). Furthermore, as it develops the Eastern half of the nation with pipeline construction to China and Eastern Siberia it will expand its use of combined heat and power generation plants (CHP) and improve its overall gasification of these regions. Measuring energy intensity will likely be a key tool in evaluating the development of these regions as they see economic growth coupled with shifts in their energy mix.

CONCLUSION

As illustrated in the previous section, Russia is a very special case where energy is concerned. It is one of the few nations in the world that is energy independent, but it is also a more developed nation with a base of educated citizens and a stable government structure. It also has demonstrated a pattern of resilience to global economic shocks and geo-political challenges. Although it suffers from many geographical challenges due to its large size and the distances involved in bringing its resources to market, none of these factors hinders it significantly in engaging in a strong initiative to becoming more energy efficient and maximizing its extensive resource base at least in the area of energy intensity measurement.

In regards to how to implement, manage, and evaluate its energy efficiency efforts there is hardly a case globally where the energy intensive method is more appropriate. The major flaws with the energy intensive model are much less obvious in the case of the Russian Federation because of its unique situation.

The fit of the energy intensity model and the positives discussed in the previous sections are fairly clear. The continued use of the energy intensity measurement tool will maintain a consistent method that policy makers and analysts have experience working with both inside and outside of the Russian Federation and this will go a long way in attracting financing and investment into not only the energy exploration arena, but also in the various midstream and downstream arenas if Russia can use energy intensity improvements as a stimulus to attract technology and appropriate capital. Small, well-illustrated examples of efficiency improvements may garner investment momentum in upgrading the aging energy networks and also promote cooperation with technology-loaded nations such as Germany and the United States.

To conclude, the use of energy intensity as a relevant and appropriate measurement tool will be a key in helping to address consumer waste, upgrade existing infrastructure, incentivizing the development of new technologies and techniques domestically, and free up additional resources for exports adding to national revenues and improving Russia's competitiveness in the global energy market.

CHAPTER 2. RUSSIAN EXTRACTION EFFICIENCY

UNDERSTANDING AND USING THE ENERGY RETURN ON ENERGY INVESTED METHOD

Assigning a value to the overall energy intensity in the oil extraction sector is difficult under the most transparent circumstances. While there is undeniably a net utility in oil production when considering the costs of inputs, including energy inputs, nailing down exact figures for each firm and in each individual production play is complex. There are many cost factors in oil production, but the most important for our study is the actual cost of energy inputs. These are the energy costs associated with the construction, operation, initial treatment, and transportation of extracted oil. Of course, this energy comes in many different forms such as electricity, natural gas, diesel fuel, and gasoline, but may include others. A method of combining these sources into workable and comparable units is needed.

In order to establish a method of estimating the amount of energy needed to extract more energy a system was created in the 1970's commonly called Energy Return on Energy Invested (ERoEI). This method was initially developed to illustrate the "peak oil" situation in the United States by illustrating that the number of energy inputs for the production of an equal output was declining drastically and that eventually it would cost more than one barrel of oil to produce another barrel of oil (Cleveland 2004). Of course, with many of these Hubberts Curve and "Peak Oil" predictions there proved to be little or no substance to their arguments as new technologies were developed to improve efficiency. However, the ERoEI method has remained and is a valuable tool in understanding relative energy efficiency in energy production.

One of the best explanations of ERoEI comes from the Energy Matters website in an article appropriately titled, "ERoEI for Beginners" (Mearns 2016). The article explains the concept and how energy conversions are done in order to establish ERoEI numbers and how those numbers can then be used to understand the net benefit of continued or potential energy projects. The focus of this article and several others on ERoEI are mostly centered on the cost of producing renewable energy sources, however, the same process can be applied to any energy project including the focus of our study. Euan Mearns breaks down the energy inputs into four categories.

1. On site energy consumption
2. Energy embedded in materials used
3. Energy consumed by labor
4. Auxiliary services

On site energy consumption is energy used in the creation of the production site itself and its immediate infrastructure requirements. Energy embedded in materials used is the energy used to make all the materials for the site including concrete, steel, machinery, etc. Energy consumed by labor is that which is used by the workers and staff at the site and includes things such as electricity for lighting and equipment, gas or coal for heating, and gasoline for generators and vehicles on site. Auxiliary services includes extended infrastructure such as roads, pipelines, transport trucks, refineries, and transmission lines for electricity.

Figure from Prieto and Hall (Figure 6) illustrates the basic mechanics of the ERoEI method in understanding the energy efficiency of production.

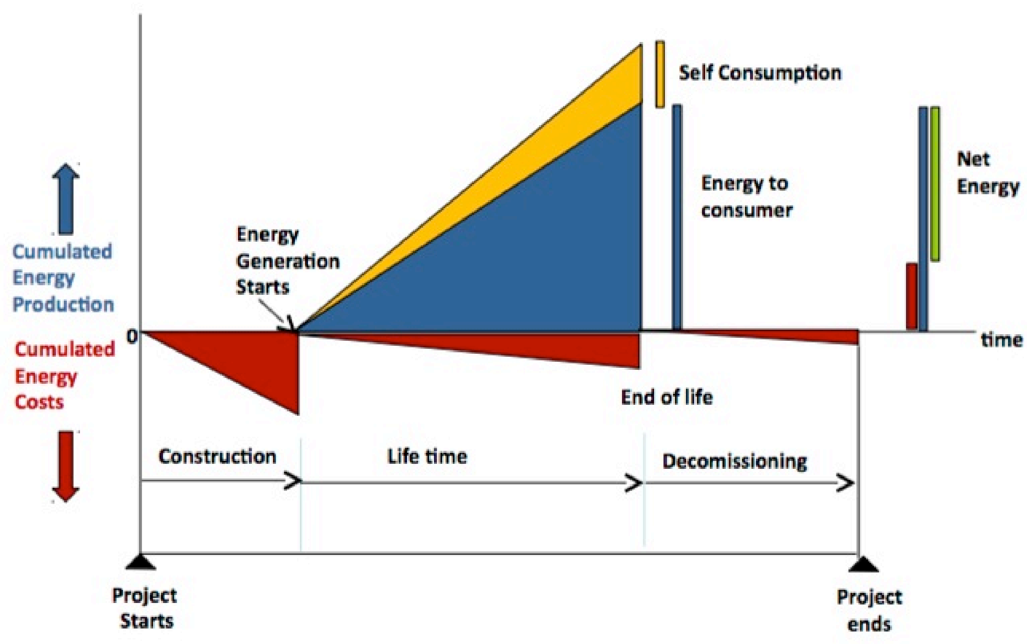


Figure 6 – Basic mechanics of the ERoEI method

Source: Presentation by Prieto and Hall

All energy is converted into a comparable format such as British Thermal Units (btu), Barrels of Oil Equivalent (BOE), or others in order to compare the total energy value of inputs to the same units of output. For example, oil and gas extraction is most often measured in BOE since the output needs little conversion but a wind farm would utilize Btu or Joules since its output is electricity. Consequently,

Net Energy = ERoEI – 1,

or one barrel of oil produced using one barrel of oil equivalent input would net zero energy return (U.S. Department of Energy Industrial Technologies Program 2006).

BROWNFIELDS, TIGHT OIL, HYDRAULIC FRACTURING AND EXTRACTION EFFICIENCY

It is a well-established model that the profitability and energy efficiency of older and more difficult fields declines rapidly because of the need for improved processes, technologies, etc. The U.S. and its "shale revolution" found its footing with the help of technologies and processes that had been developed over 30 years previously, but were deemed unprofitable. As the price of oil started to rise in the 2000s, these oil plays became economically viable, but more importantly, the processes became leaner in terms of energy efficiency and productivity as well. The U.S. had been experiencing a subsequent rapid decline in ERoEI numbers since the latter part of the 1970's, but these were quickly stabilized and, in some cases, even reversed (Lacalle 2011). Many of these technologies and processes have been or are in the process of being adopted by Russian oil companies as well (Guehria and Collaku 2014).

Although the access to technology has had some hiccups due to sanctions against the Russian Federation for the last few years, there have been a number of strides in the processes and even locally produced equipment that has extended horizontal drilling capacities, lowered production costs, and breathed new life into aging fields long abandoned by the oil majors. In the chapter on Russian Brownfield production I will discuss this in more length, but in summary here it is important to note that Russian firms are finding extraction in these difficult fields profitable (Bashneft 2016).

However, this section is not focused on the profitability of these plays, but rather on the overall energy efficiency of Russian efforts. It goes without saying, that a company will usually only operate when it can do so profitably, but if it continues to operate at an inefficient rate of energy use, then it works counter to the aim of improving the nation's overall energy intensity, which is the focus of this chapter.

What is the ERoEI number for production in brownfields? Unfortunately, we are unable to isolate data specifically for brownfields because of poor reporting and a lack of targeted data collection. However, we do have several estimates to work with from Rosstats, Russian energy firms, and from research studies on Russian energy production. Furthermore, there are many published studies on the North American energy sector ERoEI to help provide a reference point.

Total ERoEI for Russia is given in Table 3 and Figure 7 and shows relatively consistent efficiency since 2007. However, this figure is based on total hydrocarbon production and is unable to illustrate accurately the ERoEI for Brownfields. In their study of ERoEI in the gas and condensate sectors, Nogovitsyn and Sokolov determined that the ERoEI for gas production was far better than the total hydrocarbon sector average (Nogovitsys and Sokolov 2014).

Table 3 – Total ERoEI for Russia

No.	Title	2005	2006	2007	2008	2009	2010	2011	2012
1	Production, Mtoe	986.9	1009.6	1016.2	1023.4	965.0	1030.5	1053.3	1046.6
2	Energy consumption, Mtoe	27.2	29.6	34.0	34.5	31.9	32.4	32.2	34.5
3	$EROI^{dev\ and\ transp}$	36	34	30	30	30	32	33	30

Source: Nogovitsyn and Sokolov based on RossStat data

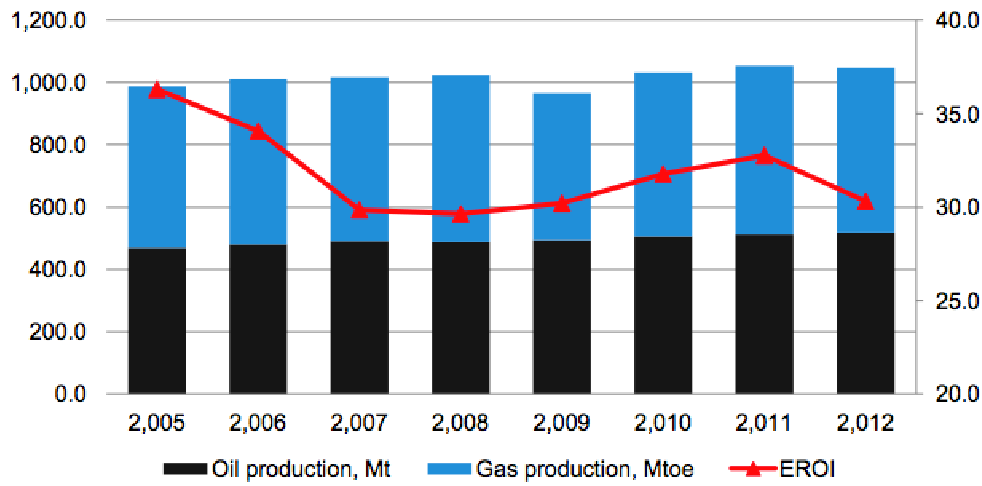


Figure 7 – Energy Return on Energy Invested in Russian Oil and Gas Sector

Source: Nogovitsyn and Sokolov based on RossStat data

Therefore, the oil sector ERoEI would appear to be less than the average ERoEI since the division in production is close to 50/50 in terms of Mtoe. Their research covered projects by several Russian gas companies with individual findings of ERoEi shown in Table 4.

Table 4 – Reported ERoEI by Russian firms

No.	Company	2010	2011	2012	2013
1	Gazprom	81	77	75	80
2	NOVATEK	129	105	76	70
3	YATEC	-	-	-	116
4	Hydrocarbon production in Russia	32	33	30	-

Source: Nogovitsyn and Sokolov

However, they also hedge their findings by suggesting that, "the situation in the oil and gas industry has come to a point when there is a need for the introduction of an energy audit" and conclude that "Rosstat's methodology of the calculation of energy consumption should be revisited and developed to show more data, at least with separation for activity sectors (Nogovitsys and Sokolov 2014, 6751)."

Taking the average ERoEI for gas production by using the Gazprom number since they are the largest gas producer by far in Russia, we get an ERoEI of 79. Gas represents 50.4% of total hydrocarbon production in Russia in 2012 and subsequently would have used 6.7 Mtoe in the production of gas. The remaining consumption would then be allocated to oil production, which is 27.8 Mtoe. This gives oil an ERoEI of 18.6 overall. This number by itself is reasonable in regards to overall energy efficiency because the amount of revenue generated far exceeds the cost of energy inputs.

Furthermore, we must consider that the bulk of energy costs, as illustrated in figure 3.1 earlier, are made up in the construction phase of energy projects. The advantage of brownfields is that most of the necessary infrastructure already exists and consequently the amount of energy used in the extraction of oil in these plays is reduced. Although we can't get a specific ERoEI figure for the Russian brownfields, we can safely assume that the ERoEI is at least 18.6 or greater based on Nogovitsys and Sokolov's study.

Another way to estimate the ERoEI in Russian oil production is to use data in other oil fields from different nations where reporting is more accurately measured. The U.S. Census Bureau in 2005 calculated oil production ERoEI for 1997 at 27 to 1, which predates the beginnings of the "shale revolution" in America. More recently, a Stanford study, funded by the Carnegie Endowment for International Peace, was done in 2015 on 40 oil fields from around the world to measure the ERoEI of oil production. The net energy return ratios (ERoEI − 1) of global oil fields not including any in Russia averaged 33. Additionally, the study noted that some fields that produced a large amount of gas condensate lowered the overall mean significantly (Brandt, et al. 2015). A report by Peak Oil shows total North American oil production at an ERoEI of 20 to 1 with significant outliers for newer fields and tar sands lowering the mean. Danille Lacalle goes on to suggest that tight oil and "fracking" may even be above the mean because of productivity and efficiency improvements (Lacalle 2011).

We can calculate the energy intensity of brownfield production by using these ERoEI and Net Energy numbers and then converting them to Tons of Oil Equivalent (Toe) and by then calculating the units of GDP in terms of thousands of dollars in 2005 terms. Tables below contain a variety of information in a progression from projected ERoEI numbers in line 1 of the first section through the extrapolation process to determine the estimated energy intensity on the last line of the last section. I have broken the table into three sections to discuss them in more detail.

Table 5 – Net Revenue (USD)

ERoEI Number (Net Energy +1)	11	11	11	21	21	21	31	31	31
Net Energy Gained (NER)	10	10	10	20	20	20	30	30	30
Oil Price per barrel (USD)	30	55	80	30	55	80	30	55	80
Net Revenue (USD)	300	550	800	600	1100	1600	900	1650	2400

Table 6 – Oil Produced for Every 1 Toe Input and Net Revenue per Toe Input (USD)

Oil Produced for every 1 Toe Input	78,573	78,573	78,573	150,003	150,003	150,003	221,433	221,433	221,433
Net Revenue per Ton of oil produced in USD (ERoEI - 1)	214,29	392,87	571,44	214,29	392,87	571,44	214,29	392,87	571,44
Net Revenue per Toe Input (USD)	2357,19	4321,52	6285,84	4500,09	8250,17	12000,24	6642,99	12178,82	17714,64
Total Contribution to GDP in USD (1 Toe input + NER Tons)	2571,48	4714,38	6857,28	4714,38	8643,03	12571,68	6857,28	12571,68	18286,08

1 Unit of GDP = USD 1000 (2005)
1 Toe = 7.143 barrels

Table 7 – Extrapolation into Energy Intensity (EI)

Energy Intensity = 1 Toe/$1000 GDP (USD)	0,39	0,21	0,15	0,21	0,12	0,08	0,15	0,08	0,05
Energy Intensity = 1 Toe/$1000 GDP (2005 USD)	0,32	0,18	0,12	0,18	0,1	0,07	0,12	0,07	0,05

Source: Author's calculations

Table 5 assigns an ERoEI number in three ranges. The first is the low efficiency range of 11 (columns 1-3), the 2nd group is the midrange ERoEI of 21 (columns 4-6), and the last is the optimistic range of 31 (columns 7-9). Row 2 shows the net energy gained (NER). Row 3 uses a range of prices per barrel of oil in international markets. These prices were determined because they coincide with the ERIRAS 2040 Forecast with 30 USD representing the low-end projection for prices, 55 USD as the mid-range, and 80 as the top end. At the time of writing, this section Brent was hovering just under 50 USD a barrel. Row 4 calculates the Net Revenue for every barrel of energy input; therefore, at an ERoEI of 11 and a price of 30 USD, net revenue for 1 barrel of oil equivalent input would return 11 barrels output for an NER of 10 and a Net Revenue of 300 USD. With higher oil prices and higher ERoEI, the Net Revenue increases, as one would expect.

Table 6 shows similar numbers but with a conversion to Tons of Oil Equivalent (Toe) as a measurement and the subsection gives the conversions (barrels to Toe) and units (1000 USD) for the calculations. Note: the deflator to 2005 USD was not used in the second section, but only in the final section, Table 4.3.3. Row 1 of this section is the amount of oil produced in tons for every one Toe of input. Each column corresponds like the previous table with ERoEI of 11, 21, and 31 and price per barrel of 30, 55, and 80 USD. The key difference in this section is the last row, which calculates the total contribution to GDP for every 1 Toe input and this figure is represented in current USD. As this section correlates similarly to the first section except for its conversion to tons versus barrels, the expected outcome is that higher efficiency (ERoEI) and higher prices provide the best results for GDP. One point of note is that the ton of oil equivalent input is added to the contribution to GDP because it represents money spent as well as money gained, both of which contribute to GDP.

Table 7 extrapolates the numbers into energy intensity (EI). The formula for this is Energy Intensity = 1 Toe/$1000 of GDP (USD) as noted in row 1. Each column corresponds exactly to the previous sections. In this section, I use the deflator to calculate the EI in 2005 USD in order to get an apple to apple comparison with data from the IEA on EI for Russia, which uses the "1 Toe/$1000 GDP (2005 USD)" measurement as a benchmark. The EI numbers for each of the columns is shows the cumulative effects for high production efficiency and higher prices on the overall EI for oil production.

The goal here is to establish, with some certainty, that oil production in Russian brownfields has reasonably low energy intensity. My target for this purpose was a figure of ERoEI ⩾ 11 or net energy gained (NER) of 10 units. The target of 10 was selected because at nearly any price for a barrel of oil from USD 30 and up, there is a net energy intensity improvement realized for the Russian Federation. A better minimum target might be ERoEI ⩾ 9 (net energy gained of 8 units), but using 10 as a benchmark allows for significant errors (about 20% on the low end) in data collection, reporting, etc. Based on the data that is accessible both in Russia and other nations, it seems prudent that Russian oil production as a whole and brownfield/tight oil production specifically can produce at, or better than, the threshold of 10 NER. Furthermore, it is extremely likely that Russian producers can achieve double or triple that threshold.

To appreciate the significance of these projected EI results, Figure 8 illustrates the 2013 energy intensity numbers from the International Energy Agency (IEA). I've included data for Russia, Sweden, and Canada for two reasons. First, all three countries have large populations living in northern regions and second, the Russian government has targeted these two countries as benchmarks for Russia's energy efficiency initiatives (Astrov 2010, 19). Referring back to the EI numbers for section 3.3.3, the worst result in EI, column 1 (11 ERoEI) is still half as intensive as the 2013 numbers for Russia as a whole. Consequently, even in the worst-case scenario regarding efficiency and price per barrel, brownfield oil production would contribute to the reduction of EI for Russia overall. In the best-case scenario of high efficiency and high prices, EI would be almost a third of Sweden's 2013 EI.

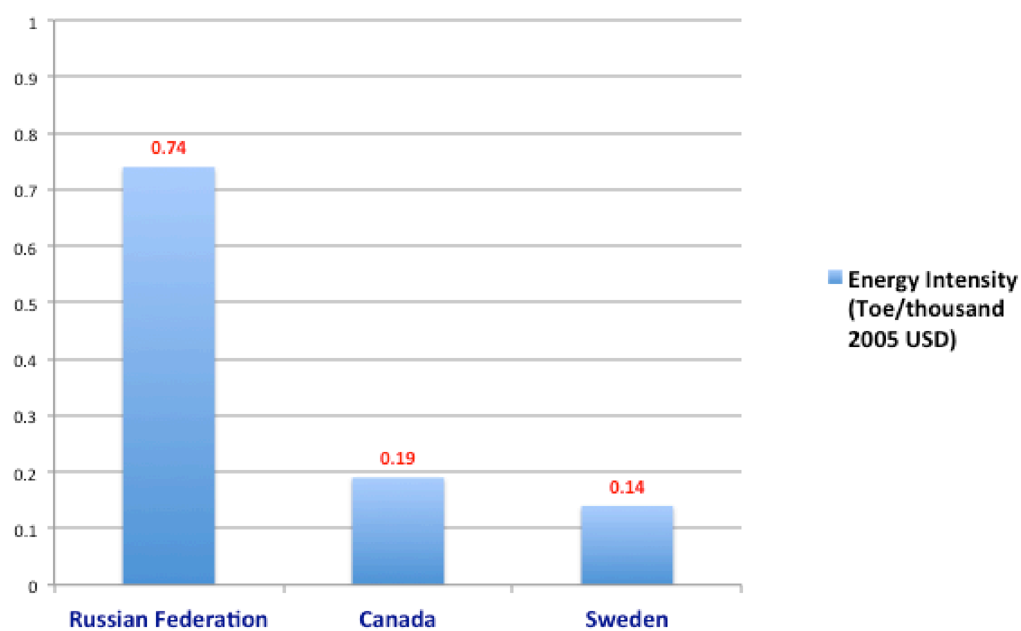


Figure 8 – 2013 Energy Intensity Country Comparison

Source: IEA Statistics Manual

CHAPTER 3. THE RUSSIAN FEDERATION ENERGY TAX REGIME

CURRENT AND POTENTIAL STRATEGIES

The Russian tax regime on oil, gas and other raw petroleum resources, like many producing nations, is complex, fluid and subject to many manipulations at different levels of government and influenced by a variety of actors. It has been a work in progress since the dissolution of the Soviet Union and Russian tax policy has struggled to find a balance between generating appropriate revenues and promoting efficiency and innovation in the fossil fuel sector as a whole (Filippov, Dil'man and Ionov 2013).

There are a number of factors that feed into this taxation environment. Primary among these is the need to maximize tax revenues from the largest contributor, the oil and gas sector, to the economy. Secondary factors include the huge profits that fossil fuel companies are able to generate, which makes them an easy target when policy makers are struggling to fund domestic programs as well as the associated power distribution within the government at all levels that can be attributed to fossil fuel taxation and policy. Furthermore, there are a variety of actors within the energy sector with substantial influence on policy makers through personal connections or successful lobbying efforts (Henderson 2015). Lastly, there is the long-term strategy for Russia itself in developing into a full-fledged Western style economy that doesn't solely rely on resources and therefore puts pressure on tax policy to help promote more efficient use of domestic resources and give Russia the biggest and most sustainable bang for its buck (Goldsworthy and Zakharova 2010, 3).

The most significant method of taxation on the oil and gas sector in Russia is the Mineral Extraction Tax (MET). The MET represents the bulk of collected taxes from oil and associated gas production. Table 3.1 lists the quantity of taxes collected from 2011 through 2013 through the various forms of taxation in the Russian Federation for oil exploration and production in thousand Rubles. Figure 9 illustrates more clearly how the MET dominates the other categories as a revenue generation tool for the Russian Federation using only the 2013 figures, but they are fairly consistent with previous years. In 2011 the MET was 82% of total tax revenues and it grew slightly to 83% in 2012 and just under 84% in 2013 (Khafizova and Fassakhov 2015, 21-22).

Table 8 – Russian Tax Revenues from Oil and Associated Gases by Category, thousand RUB

Tax category	2011	2012	2013
Total tax revenues on crude oil and associated gas production	1871639227	2164586716	2252806719
Corporate Income Tax	212949710	204391369	151436495
Individual Income Tax	15381247	17456722	18503855

Tax category	2011	2012	2013
Value-added Tax	51361257	68465083	95515165
Excise Taxes	834256	14651150	38127180
Mineral Extraction Tax	1537431099	1803815074	1888573483
Other Federal Taxes and Duties	842449	178421	94044
Regional Taxes	36630836	40133554	45100886
Local Taxes	194136	242883	300533
Taxes subject to special tax treatment	16014237	15385550	15155078

Source: Data from Khafizova and Fassakhov 2015

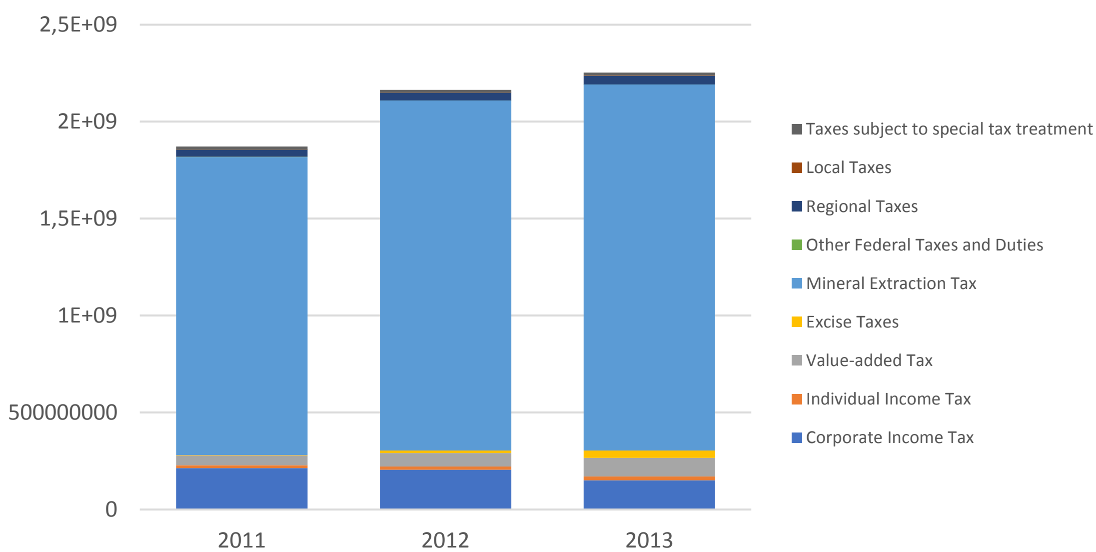


Figure 9 – Crude Oil and Associated Gas Revenues by Tax Category, 2011-2013, thousand RUB

Source: based on data from Khafizova and Fassakhov 2015

The MET dominated tax regime was instituted in January of 2002 under much debate about the effectiveness of such a system. It was argued by many that the elimination of Production Sharing Agreements (PSAs) in Russia would diminish competitiveness, extraction rates, and the attractiveness of Russia for Foreign Direct Investment. Furthermore, many analysts and economists warned that the overall tax revenues from oil and gas exploration and production would be reduced. Among the arguments made against the switch in tax regimes was that of Dr. Andrey Konoplyanik who illustrated his point in an article in 2003 while he as the Deputy General Secretary of the Energy Charter Secretariat (A. Konoplyanik, Multiple Investment Regimes for Russian Subsoil Resources: A Work in Progress or Utopia? 2014). The key differences between the tax regime under PSAs and that of the MET is that the MET uses a flat rate for every ton of oil extracted whereas the PSAs where designed on a graduated tax scale based on the ease of which resources could be extracted. The core of Dr. Konoplyanik's argument can be seen in figures below where he refers to the MET as a Mineral Resource Production Tax (MPRT). The first of these figures (Figure 10, A) shows the point at which companies stop producing which is equal to the MRPT level. The second figure (Figure 10, B) shows how rents and revenues would be dispersed in a PSA system. In the third figure (Figure 11), these distributions are overlapped to illustrate the advantages for both the extracting companies and the state in regards to revenue. Furthermore, it shows why the PSA system maximizes efficient use of mineral resources overall. The three figures are borrowed from Dr. Konoplyanik (A. Konoplyanik, Multiple Investment Regimes for Russian Subsoil Resources: A Work in Progress or Utopia? 2014).

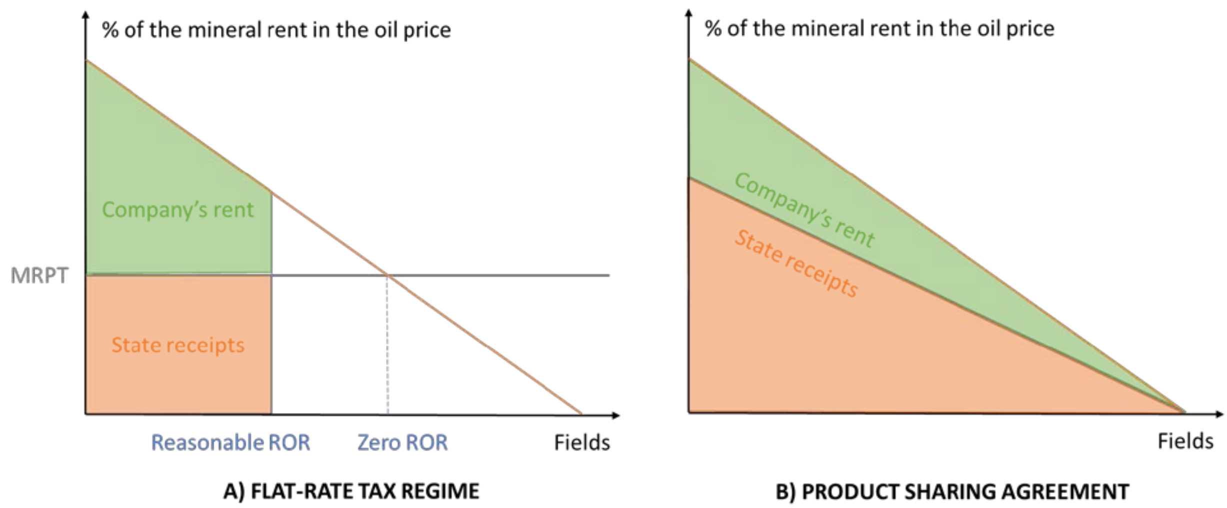
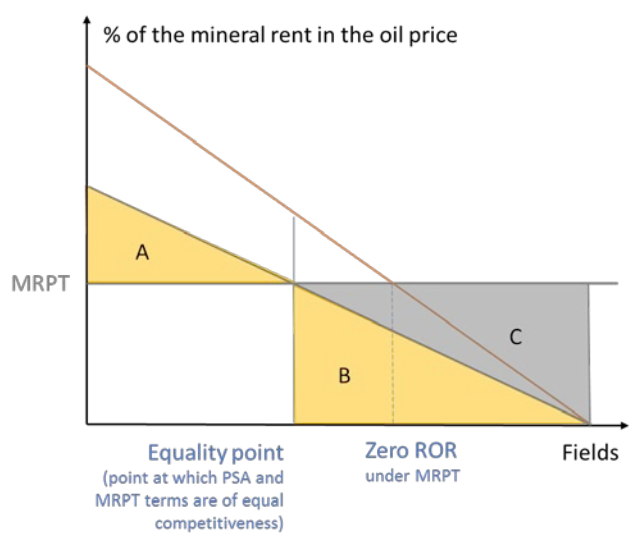


Figure 10 – Comparison of rents from a flat rate tax system and graduated system

Source: A. Konoplyanik



A: Companies' incremental rent-type earnings under MRPT, which transferred into state take under PSAs

B: Revenues that the opponents of PSAs wrongly claim are lost to the state under transition to PSAs

C: Incremental state earnings under PSAs through development of non-profitable fields inder MRPT with flat rate

Figure 11 – Transfer from MRPT to PSA

Source: A. Konoplyanik

One of the key arguments against a flat tax on extraction is that it only encourages the harvesting of the lowest hanging fruit in so much as the easiest to extract resources would be taken until the returns to the producing firm were exhausted. Consequently, tax revenues from fields would stop once the extracting firm reached a breakeven point and this historically has led to fields being abandoned with as much as 20% of their proven reserves still in the ground. Therefore, a graduated tax regime that decreased as reserves became harder or more costly to extract would incentivize the more efficient use/extraction of the resources and continue to provide tax revenues. Moreover, the argument is that the extraction of the hard to reach fruit would generate experience and innovation in the sector such as it has in the U.S. This, in turn, could provide growth in the Russian oil services sector and relieve the domestic industry from relying so heavily on foreign oil service companies from the West such as Haliburton, Baker Hughes and others.

Despite these arguments, the Russian MET tax regime remained in place with little adjustment until the last few years. In 2014, the MET was raised again on oil with the base rates going from 493 Rubles per ton to 766 in 2015, 857 in 2016 and 919 in 2017. However, tax holidays, incentives and adjustable coefficients were created for the express reason of encouraging investment and development in older fields with more difficult extraction requirements and for new fields considered of high importance to the overall Russian economic strategy (Ernst and Young 2014). The system is based on a complex formula that is explained in the formula in the box below.

Box 1 – Russian Oil Taxation Formula for MET

Beginning in January 2015 $\mathbf{BR \times C_P - E_M}$

Where:

BR is the base rate of the MET

C_P is a value based on the price of Urals grade crude and exchange rates.

E_M represents oil extraction factors and the coefficients assigned to them.

$$\mathbf{E_M = C_{MET}{}^{x}C_p{}^{x}(1C_D{}^{x}C_R{}^{x}C_{DE}{}^{x}C_{RD}{}^{xC}{}_{CAN})}$$

A more detailed explanation of each of these variables is explained in the EY publication (Ernst and Young 2014).

Adjusting the coefficients in any part of the EM portion of the MET can significantly reduced the tax obligations of a particular project and there are a wide variety of effects on the net MET tax on these projects. Furthermore, tax credits and exemptions are also applied to certain projects such as those currently in use in Tartarstan fields of 1200 Rubles per ton or a 0% MET for high viscosity (heavy) oil.

Proponents of this system point to these credits and adjustments as evidence that tax relief for the express purpose of spurring production is being used and used effectively for a variety of situations. Also, these manipulations of the tax regime are tailored to individual project needs (Maryina 2016). It is further argued that this system avoids a “one size fits all” approach to the complexities of oil and gas extraction especially given the diverse environment of Russian energy reserves that span the whole of Asia and include offshore and Arctic development as well. Another well-documented concern of both the Russian Ministry of Finance and Ministry of Natural Resources is that reporting from oil and gas companies can be easily manipulated to the benefit of the firm and at the expense of state revenues. The accumulation of huge amounts of assets by energy companies in the 90's and early 2000's provided the catalyst for the changes in the taxation system to begin with (Gusilov 2011).

Current arguments against the MET system are similar to those made by Dr. Konoplyanik that were referenced earlier, but with some additional caveats and these arguments come mostly from the energy industry itself or from energy analysts and academics (Maryina 2016). Although many applaud the steps taken by the Russian government to adjust the MET in order to encourage more production, they also argue that the complexity of such a process adds to bureaucracy and slows the market's ability to adjust quickly to changing circumstances. Specifically, the application for exemptions, credits, and reductions in the MET coefficients requires extensive lobbying efforts on the part of producers. This system gives a significant advantage to the largest firms that have well-established relationships with ministry officials and some even have company officials sitting on oversight and strategic boards within the government. Consequently, it creates a competitive barrier for smaller and newer firms to enter the market in precisely the area that needs the innovative and creative approaches that are often provided by small and medium firms as evidenced in U.S. production (A. Konoplyanik, Multiple Investment Regimes for Russian Subsoil Resources: A Work in Progress or Utopia? 2014) (Maryina 2016).

CONCLUSION

To summarize, the MET in Russia is complicated and can be difficult to navigate, but it appears to be here to stay in the immediate future. The system itself is unique in comparison to other oil producing countries, but efforts have been made by the Russian government to spur production and improve overall resource extraction management. The results of these efforts vary as widely as the MET system itself and extraction rates and overall oil production in heavily developed "Brownfields" will be further discussed in chapter five.

Chapter 4. Russian Brownfield Production

A Brief History of Russian Brownfields

Russia has been producing large quantities of oil in Western Siberia and in its Southern regions near the Caspian Sea and Volga River since the Soviet era. The Western Siberian basin, pictured below is immense, and formed the backbone of Soviet oil production starting from the 1960's and 1970's. While not as large, the Volga-Urals region and wells located in the Bashkortastan and Tatarstan regions also contribute significantly to Russian oil production. The terms Brownfields and Greenfields are a way to distinguish a field's production life cycle. These older fields are referred to as Brownfields because they passed their peak in terms of production whereas Greenfields refer to those in their early stages of development.

According to Lukoil, 90% of Russian oil production comes from fields that were discovered before 1988 with the remaining 10% coming from regions that are remote, have challenging climate and weather issues, and a lack of infrastructure (Lukoil 2015, 43). However, in the last decade those fields had begun to see sharp declines in production as the most easily extracted reserves became depleted. A decline in production from these brownfields, often called Soviet legacy fields, began in 2004 with around a 2% decline, but the speed of the decline increased rapidly reaching between 10 and 12 percent until stabilizing near 10% annually in 2010. These fields have well-developed infrastructure including pipelines, utilities, and access to large population bases. Figures below (Figure 12, Figure 13) give a more detailed view of the geography of Russian oil and gas extraction.

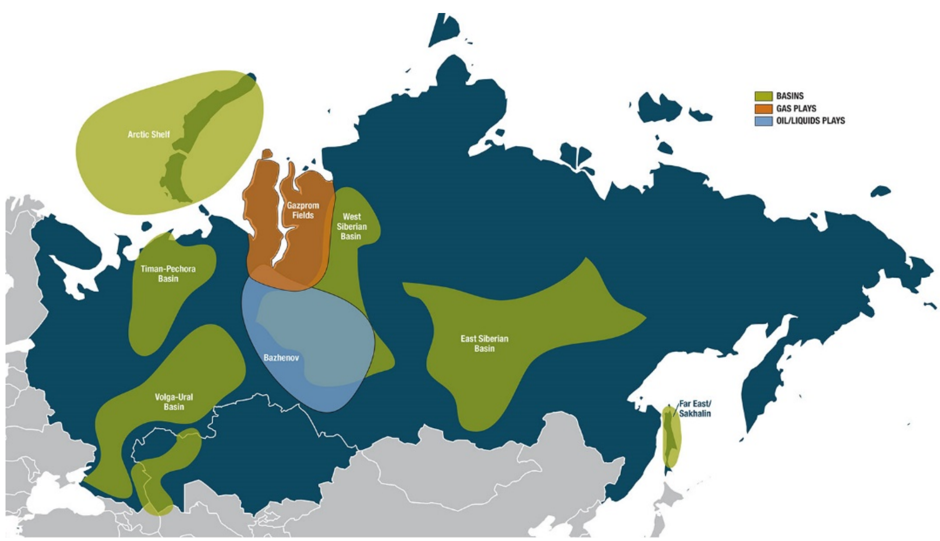


Figure 12 – Location of Russian Oil and Gas Reserves

Oil and natural gas production in Russia (2013)

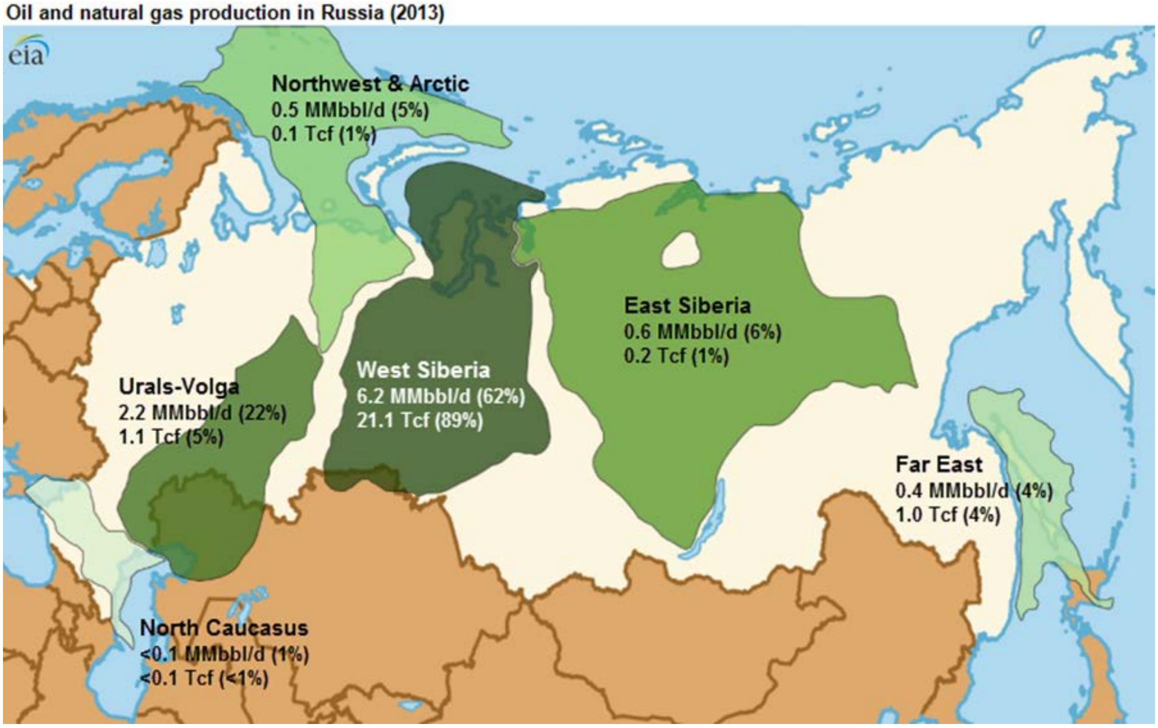


Figure 13 – Oil and Natural Gas Production in Russia

Source: U.S. EIA 2013

CURRENT RUSSIAN OIL PRODUCTION

With over 10 million barrels of oil produced a day, Russia continually ranks in the top 3 producers in the world with the United States and Saudi Arabia. Figure 14 shows recent annual U.S., Russian and Saudi output of oil, but even more recent data estimates a change in production rankings with the U.S. position reduced to third. Despite earlier declines in brownfield production, Russia was been able to increase overall production from 2009 to present and production continues to grow. Part of the reason can be attributed to new fields coming online such as the development of Sakhalin Island, Arctic production, and others, but other factors include the adaptation and implementation of better extraction technologies, other efficiency improvements, and changes to the tax regime.

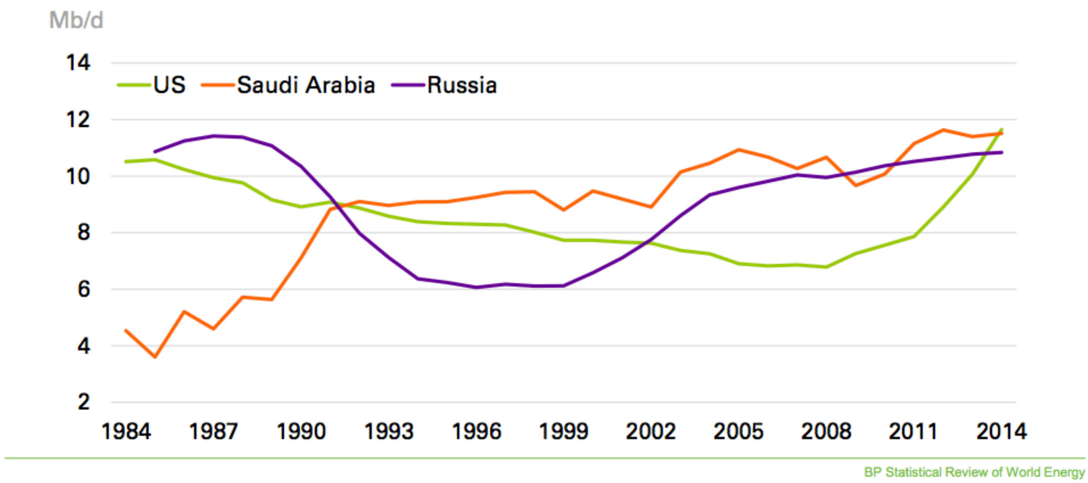


Figure 14 – Largest World Oil Producers

Source: Drebentsov Presentation at European University St. Petersburg April 2016

During a presentation by British Petroleum's Vladimir Drebentsov in April 2016, it was discussed how Russian major oil companies had increased their overall production from 2009 to 2014, but that in 2015 there was a change in the overall Russian production dynamic. Namely, that the majors had experienced significant declines in production, but that overall Russian production had increased (Drebentsov 2016). ***Figure 15*** shows how Russian energy companies performed in 2014 versus 2009 and demonstrates how most companies were able to increase or maintain their production levels during that timeframe. The most notable increase in this period comes from the "Other Producers" category and Bashneft. Furthermore, as Figure 16 demonstrates, in 2015 Russia's largest oil producer, Rosneft, joins the ranks of declining producers but the overall output still continues to grow.

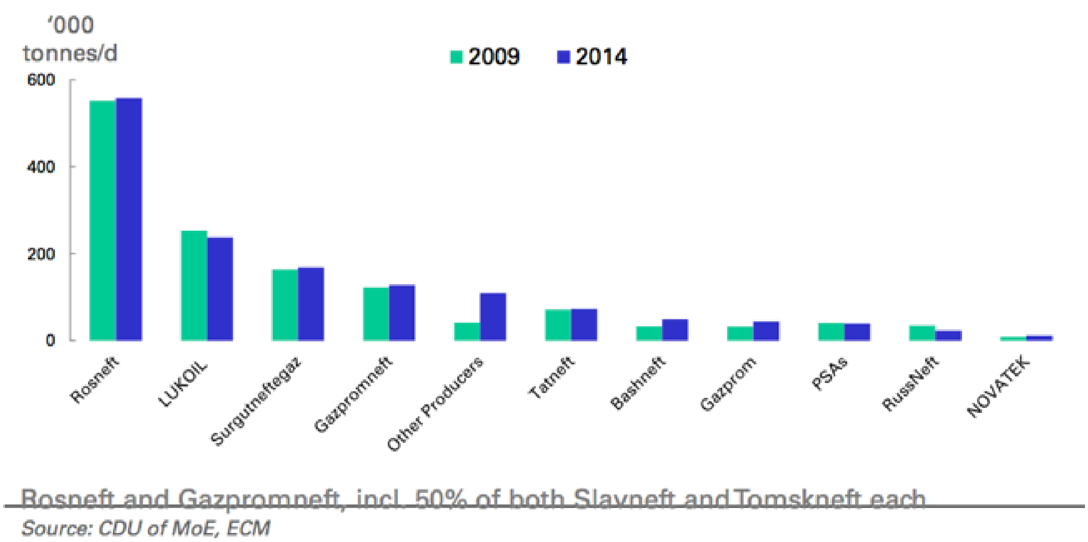


Figure 15 – Russian Oil Output by Company

Source: Drebentsov Presentation at European University St. Petersburg April 2016

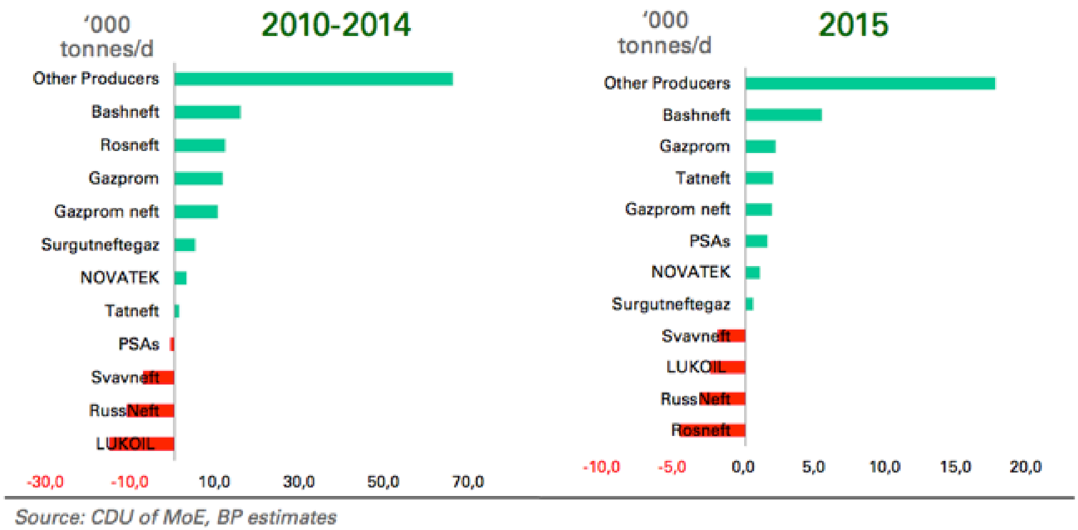


Figure 16 – Incremental Oil Output in Russia: SME driven growth

Source: Drebentsov Presentation at European University St. Petersburg April 2016.

Russian production growth has defied most output predictions from both Western and Russian analysts including the IEA, EIA, and ERIRAS. The general sentiment has been that technological and efficiency improvements couldn't stall the rate of decline and that new fields could not be brought online quickly enough to offset the losses. Further exacerbating the problem, have been the implementation of sanctions, a massive decrease in world oil prices, and a weakening of the ruble. And yet, even in 2016, year on year production is increasing as shown in Figure 17. So, what factors have enabled Russia to increase production in the face of such difficulties?

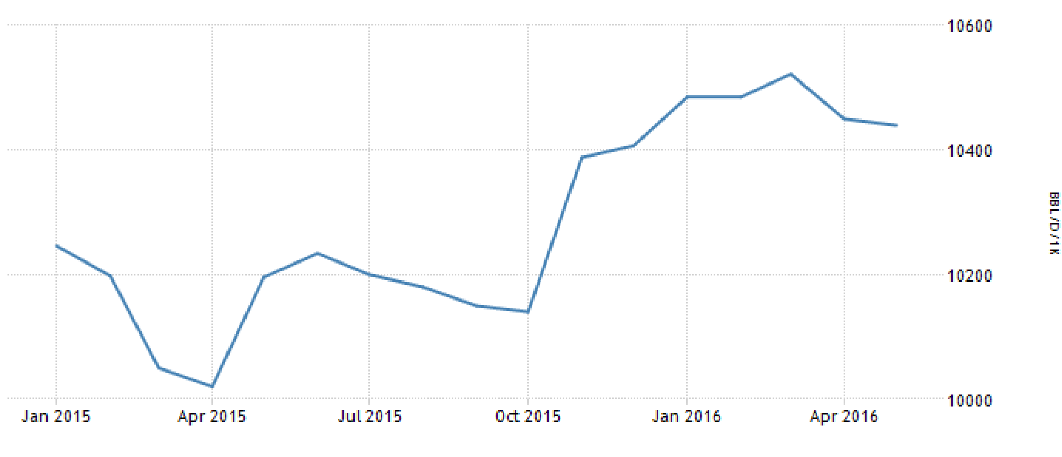


Figure 17 – Russian Crude Oil Production in Bbl

Source: TradingEconomics.com

There are four common explanations for continued Russian output increases put forth by analysts of the Russian oil industry and financial sectors such as Bloomberg and Fitch ratings:

1. The value of the Ruble has mirrored the drop in oil prices lowering the Russian breakeven on oil production. Bloomberg Technology even quoted Rosneft's Igor Sechin as boasting, "his expenses are the lowest in the world." The article also quoted IHS Russia as claiming that for every $10 USD drop in prices, the average Russian production margins only dropped by $1 USD (Khrennikova 2015).
2. Russia is seeking to gain market share in the global oil market while prices are low by outlasting their competition such as the U.S. and Canada with higher production costs (Oil Price.com 2016).
3. Improvements in Oil Recovery Factor (ORF) and operational efficiency in Russian production is exceeding expectations. An additional caveat to this explanation is the emergence of leaner, more efficient small and medium enterprises (SME) in the oil production sector (Drebentsov 2016).
4. Various changes in the MET over the last several years including a significant overhaul in 2014. The change has allowed companies to profitably access difficult reserves with unconventional methods or helped incentivize conventional well extraction in brownfields (Maryina 2016).

I will quickly point out why the first two explanations are flawed and then will evaluate the second two in more detail. If better margins or a gain of market share were the driving forces behind Russia's production growth, then we would see an increase from the major Russian companies as well as the smaller producers. However, as noted in Figure 17, this is not the case despite Sechin's "lowest cost" statement. This leaves the last two explanations as the major factors driving production. Of course, there are likely a plethora of smaller, individual factors that have some impact, but these are negligible on a macro analysis.

IMPROVING THE OIL RECOVERY FACTOR, INFILL DRILLING AND GETTING LEANER

One of the central themes in recent years in the Russian oil industry has been the need for domestically produced extraction equipment for multi-stage hydraulic fracturing, the extension of horizontal drilling capacity, and software development to better utilize harder to reach mineral deposits. In its Global Trends to 2025 report, LukOil devotes quite a bit of energy and space on the need to improve the Oil Recovery Factor (ORF) in Russia (Lukoil 2015). Russia has lagged significantly behind the West in terms of developing and utilizing its own extraction tools and methods. It has come to depend on importing this technology and/or contracting Western oil service companies to assist in nearly every stage of the upstream process. Some estimates place Arctic and offshore plays as 90-95% dependent on foreign equipment and software (Henderson 2015). Figure 18 shows Lukoil's estimation of where Russian producers stand in regards to ORF as of 2015.

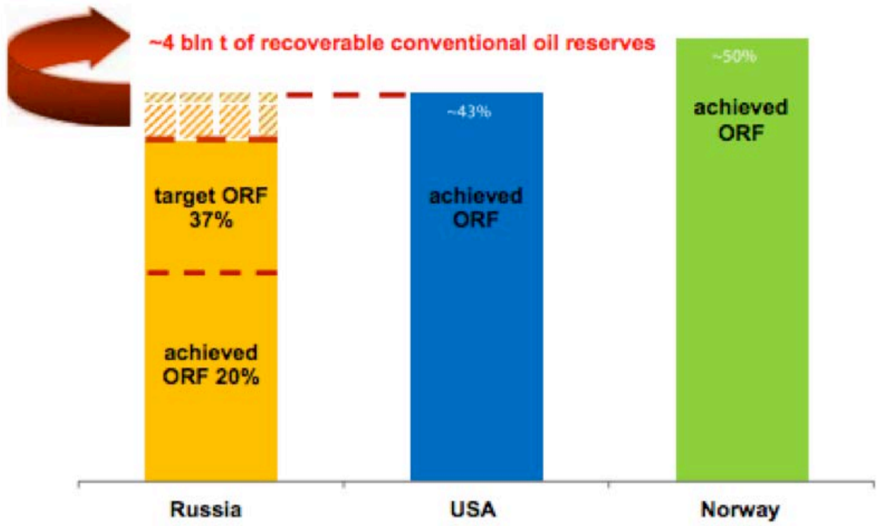


Figure 18 – Potential for Increasing Oil Recovery Factor (ORF)

Source: Lukoil

Tatiana Mitrova stated in a May 2016 report for CSIS that Russia was still heavily dependent on foreign technology and that processes and improvements were not significant currently. Mitrova did add that, "One could also expect that in the medium term, Russian equipment manufacturers will be able to produce their own analogues for fracturing, which would eventually reduce the dependence of the Russian oil industry on imports." (Mitrova 2016, 29) However, at present most analysts and many firms don't have much faith in domestically supplied innovations or the implementation of significantly better practices.

Two contributing factors to a lack of these technologies have been the sanctions regime instituted by the U.S. and the EU and the high cost of the technologies in the current low oil price scenario. This indeed does have an effect on large Russian oil companies especially since many of them and/or their major shareholders are specifically targeted by the sanctions regime. But, the smaller companies that are making the biggest production strides are not saddles with these hurdles. In fact, because of the fluctuation in the ruble, these firms have been able to maintain capital expenditures and utilize infill drilling to offset declines in brownfields (Mitrova 2016).

One example in which we have significant data is Bashneft. As illustrated above, Bashneft has grown its production consistently for the last six years. Bashneft operates almost exclusively in Brownfields, most of which are located in Bashkortostan and these fields have been in operation since the 1930's and 1950's. Bashneft has used a variety of methods including utilizing new seismic equipment to explore new facets of these fields and to reveal new opportunities for extraction. Table 9 from the Bashneft site illustrates the importance of these approaches in improving their production.

Table 9 – Oil Production Growth in Thousand Tons by Technology

Geological and Engineering Operations	2012	2013	2014
Optimization of pumping equipment	357.9	382.9	306.9
Hydraulic fracturing	235.2	489.8	679.7
Matrix stimulation	206.8	116.3	120.7
Reperforation	209.9	206.2	290.2
Commissioning of new wells	288.7	525.7	866.3
Development of overlying or underlying formations	130.0	87.5	120.1
Other	83.7	101.4	235.9
Total	**1,512.2**	**1,909.9**	**2,619.8**

Source: Bashneft

Bashneft's success in Brownfields isn't limited to Bashkortostan either. They have been able to duplicate the results in other areas as well. Although 182 out of the 194 fields they have in operation are located in Bashkortostan, Table 10 shows improvements in other Brownfields they operate in (Bashneft 2016).

Table 10 – Oil Production Growth by Region

Oil Production by Region in Million Tons	2012	2013	2014
Republic of Bashkortostan	14.7	15.1	15.7
Khanty-Mansi Autonomous District	0.4	0.3	0.9
Orenburg Region	0.2	0.2	0.2
Republic of Tatarstan	0.2	0.2	0.14
Nenets Autonomous District	0	0.3	0.8
Total	**15.4**	**16.1**	**17.8**

Source: Bashneft

THE IMPACT OF CHANGES IN THE TAX REGIME

As discussed in the earlier chapter on the Mineral Extraction Tax (MET), the Russian government has made a series of adjustments to the tax regime for oil over the last several years. The system is complex and highly individualized for specific operations within the oil and gas sphere. Oil companies have argued for years for a change to the system in order to promote growth in the sector, but the changes they have received are not what they had envisioned. It has been argued that the MET should be replaced with a profit based taxation system and instead a system for tax exemptions, preferences, holidays, etc. was implemented (Maryina 2016).

One of these areas that has received substantial exemptions and preferences are Brownfields and many of the SME operations in Western Siberia, Tatarstan, Bashkortostan, and others have benefitted. A zero rate has even been applied to many of these "ultra-heavy oil" plays and this has slowed the decline in production in Western Siberia and other locations. Eastern Siberian Greenfields have also been given time sensitive exemptions that have led to production coming online earlier than expected and helping to offset declines in other areas. Sberbank Investment Research has estimated that nearly 20% of all Russian liquids have one or more tax incentives and that this figure will rise to 30% by 2021 according to Tatiana Mitrova (Mitrova 2016, 26). Table 11 demonstrates how adjustments in tax rates have allowed Russian companies to continue production increases despite the decline in global prices. The average Netback per barrel is slightly more than $4 USD less per barrel of Urals grade crude at $46.14 USD despite a nearly $50 USD sale price decrease.

Table 11 – Taxation and Average Costs per Barrel of Russian Oil (USD/bbl)

	Urals price	MET	Export duty	OPEX	Transportation	Netback
July 2014	105,15	23,23	51,33	4,44	8,25	17,89
December 2014	60,9	11,83	25,22	2,77	5,11	15,96
January 2015	46,14	12,63	12,91	2,49	4,59	13,53

Source Ministry of Finance of the Russian Federation

Incentives such as the 0 coefficient for ultra heavy oils or 1200 rubles per ton tax deductions have been in use in Tatarstan for several years and will expire at the end of 2016, but will remain in effect in areas such as Bashkortostan, Khanty-Mansi, and others until the end of 2018. As I discussed earlier, Bashneft, which has been a leader amongst the better performers has directly benefitted from these incentives and has parlayed them into demonstrable increases in production and revenue.

CONCLUSION

There is a clear relationship between the creation of tax incentives linked to the MET and the increase in production over the last several years. While improvements in methodology, efficiency, and technological improvements have made some impact on the increased production, they have done so mostly by the incentivization of the extraction process itself. Without the tax reforms, it is unlikely that such a surge in production from brownfields would have occurred even with the best practices approach of firms like Bashneft and other SME’s without a tax structure that allowed these plays to be profitable and less risky. Additionally, as noted by Mitrova, many Greenfields have rushed into production in order to enjoy these same benefits.

CONCLUSION

I have walked the reader through a natural progression in evaluating if Russia's MET could serve as a policy tool for improving Russia's overall energy efficiency. I believe I have presented a logical process accompanied by a thorough explanation of the factors that govern and influence energy efficiency, oil extraction in older resource fields, and how the MET impacts production in these fields.

The first step in this process was to understand how energy efficiency is measured and what factors impact it. Using the standard Energy Intensity method is, and will continue to be, the key performance indicator (KPI) for Russian energy efficiency and relies on the measurement of total energy consumed per unit of Gross Domestic Product. Based on this KPI, it is understandable that any substantial increase in GDP without a large increase in energy use would then create a net gain/decrease in EI for Russia. Conversely, any significant decrease in energy use without an accompanying decrease in GDP would achieve similar results. Given Russia's unique position as a net exporter of nearly every form of primary energy, it stands to reason that it would be best served by focusing on increasing GDP in the form of export revenues.

This conclusion led me to the next stage, which was to determine if extraction of oil was in itself efficient. Here, I introduced the ERoEI method as a way of evaluating the overall energy efficiency of oil extraction with a focus primarily on oil reserves that required more advanced techniques in extraction and/or were more difficult to access such as Russian Brownfields in Western Siberia and in the Volga-Urals region. Data available in this sphere of research was far more limited, but I was able to make very plausible estimates using what data I was able to obtain both in Russian and in similar projects abroad. Using my own estimates based on this data as explained in the chapter, I concluded that even at the lowest projection of ERoEI (NER 10) at the lowest projected price point ($30 USD), production of oil in these regions would be substantially lower (nearly 50%) than Russia's current EI level. Therefore, any increase in production would provide a net gain in EI for Russia as a whole. Furthermore, higher NER combined with higher price points would exponentially improve the EI to levels at or below those of Canada and Sweden. It is my belief that ERoEI will improve over time due to experience and better management creating an even greater net benefit to overall Russian energy efficiency. Of course, oil production is only one facet of the overall EI for the RF, but producing large amounts of GDP growth with extremely low amounts of energy use would provide a huge advancement in EI. Considering the dominant role that energy exports play in overall GDP for Russia, the energy efficiency impact would be considerable.

Moving forward with the understanding that oil extraction, even in Brownfields, is an energy efficient enterprise, I addressed the issue of taxation in the RF. Specifically, I explained how the MET works and how it generates the largest amount of revenue under the current tax regime for the Russian government. However, using research done by Dr. Andrey

Konoplyanik and others, I concluded that the MET was preventing the full realization of oil reserves, especially in Brownfields where the costs of extraction created a disincentive for companies to continue drilling. As a result, the MET was generating less than optimal levels of tax revenues because it was getting a large percentage of 0. Therefore, changes in the tax regime could spur growth in production.

At the next stage I explored Russia's continued production increases despite declines in the world price of oil. Again, I focused more on Brownfield production and determined that these fields were key contributors to Russia's oil production growth. Here, there is a clear correlative relationship between MET tax incentives and other mechanisms in the growth of production. This is especially true in Brownfields. Using the more concrete data provided, I was able to link these changes in the tax regime to production increases demonstrating that the MET can be used as an instrument to spur production and was indeed already in use albeit on a more limited scale than the sliding tax system suggested in the earlier chapter on taxes.

Can Russia's Mineral Extraction Tax be used as an instrument in improving Russia's overall energy intensity? My findings indicate the answer is yes. Based on this, Russia should continue to play to its unique strengths in resource production. The European model of fuel substitution is not the best fit for Russian efficiency improvements. Will this strategy improve the Russian EI to levels on par with Sweden or Canada? It is not likely to do so on its own, however, combined with other initiatives in the consumption sectors of the economy, it is certainly achievable. Additionally, most of the tax incentives and exemptions that are currently being utilized by producers are set to expire. Consequently, as Tatiana Mitrova warns, these production increases may be only medium term solutions. Therefore, a broader utilization of MET incentives or a universal sliding scale system with decreases in the MET corresponding to more complex extraction is the best course of action.

Furthermore, there are some other byproducts of such an approach to improving energy efficiency in Russia that could be important. One of my key findings here is that there is considerable growth in SMEs operating in the extraction process. These enterprises number in the 100s and are reminiscent to the "shale oil boom" in the U.S. where 1000s of SMEs have been instrumental in the growth of U.S. oil and gas production. If changes to the tax regime have an additional impact on the oil sector in creating new, smaller companies then there are many associated potential benefits. These benefits include better competition, improved technological skills and experience, homegrown innovations, import substitution opportunities, and less reliance on foreign oil service companies and their products.

Areas for further exploration and study should include a more comprehensive and detailed method of tracking ERoEI and energy intensity in the oil and gas sector. Also, continued research on the performance of tax policy on production and extraction development methods is necessary.

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