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Energy Efficiency in Russia:

Untapped Reserves

The study has been prepared
in close cooperation with
the Center for Energy Efficiency

This study was prepared by the World Bank Group in close cooperation with the Center for energy efficiency (CENEF).



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The World Bank

1818 H. Street, NW
Washington, DC 20433 USA
Tel: +(1202) 473-1000
Fax: +(1202) 477-63-91
www.worldbank.org

International Finance Corporation
IFC Advisory Services in Eastern Europe and Central Asia

2121 Pennsylvania Avenue, NW
Washington, DC 20433 USA
Tel: +(1202) 458-0917
Fax: +(1202) 974-4312
www.ifc.org/pep

Table of Contents

Acronyms

AAU – Assigned Amount Units
APG – Associated Petroleum Gas
bcm – Billion Cubic Meters
BR – Building Regulation
BRIC – Brazil, Russia, India and China
CENEf – Russia's Center for Energy Efficiency
CHP – Combined Heat and Power Plant
COMECON – Council for Mutual Economic Assistance
CSE – Cost of Saved Energy
DSM – Demand Side Management
EBRD – European Bank for Reconstruction and Development
EE – Energy Efficiency
EEBPP – UK Energy Efficiency Best Practice Program
EMAS – Eco-Management Audit Scheme
EMF – Economy Modernization Fund
EPA – Environmental Protection Agency
EPC – Energy Performance Contracts
ESCO – Energy Service Company
EU – European Union
FBI – Federal Buildings Initiative
FEMP – Federal Energy Management Program
Gcal – Gigacalorie
gce – Grams of coal equivalent
GDP – Gross Domestic Product
GHG – Greenhouse Gases
GIS – Green Investment Scheme
GJ – Giga-Joules
HOA – Homeowners Association
IEA – International Energy Agency
kgoe – Kilograms of Oil Equivalent
kWh – Kilowatt-Hours
MED – Russian Ministry of Economy
MEPS – Minimum Energy Performance Standard
MPC – Minimum Performance Criteria
MUP – Municipal Unitary Enterprise
mtoe – Million Tons of Oil Equivalent
MW – Mega-Watts
MWt – Mega-Watt thermal
NAAQ – National Air Quality Standards
NEDO – New Energy and Industrial Technology Development Organization
NEMA – National Electrical Manufacturers Association
NESHP – National Emissions Standards for Hazardous Pollutants
NGO – Non-Governmental Organization
NPG – Norwegian Petroleum Directorate
OECD – Organization for Economic Cooperation and Development
PO – Public Organization
PPP – Purchasing Power Parity
RAO UES – Russia's Unified Energy Systems (Russian electricity company)
ROSSTAT – Russia's Federal State Statistics Service
RUR – Russian Ruble
SEC – Specific Energy Consumption
SME – Small and Medium Enterprises
toe – Tons of Oil Equivalent
TOU – Time Of Use
UNDP – United Nations Development Programme
WB – World Bank
YOLL – Years of Life Lost

EXECUTIVE SUMMARY

This report was designed to provide senior Russian policymakers with a comprehensive and practical analysis of energy efficiency in Russia: potential, benefits, and recommendations on how to fully tap into this resource. Shortly after his inauguration, President Medvedev made several public statements identifying Russia's inefficient use of energy, and the associated economic and ecological consequences, as one of the most pressing problems facing the nation. He has called for an action plan to halve Russia's energy intensity by 2020. The goal of this report is to make a significant contribution toward developing such a plan.

POTENTIAL

Russia can save 45 percent of its total primary energy consumption

Russia's current energy inefficiency is equal to the annual primary energy consumption of France. Achieving Russia's full energy efficiency potential would cost a total of $320 billion to the economy and result in annual costs savings to investors and end users of about $80 billion[i], paying back in just four years. Benefits to the total economy are much higher: $120-150 billion[ii] per annum of energy cost savings and additional earnings from gas exports.

By realizing its energy efficiency potential Russia can save:

- 240 billion cubic meters of natural gas,
- 340 billion kWh of electricity,
- 89 million tons of coal, and
- 43 million tons of crude oil and equivalents in the form of refined petroleum products.

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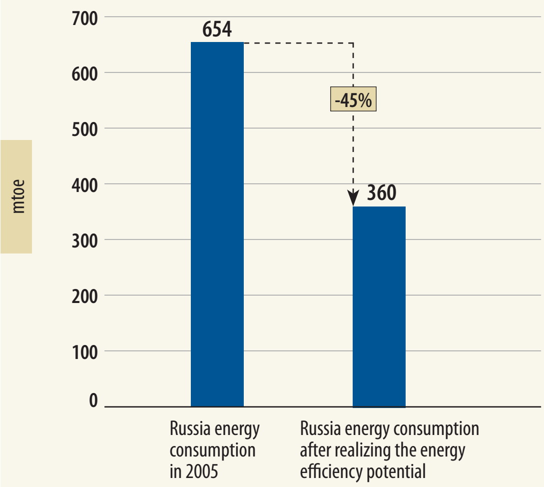
i In 2007 internal prices.

ii The range depends on which gas export prices are used for the calculation. This study considered gas prices ranging from $230-350 per thousand cubic meter.

Figure 1. Russia energy efficiency potential, investment and benefits



Total incremental investments:	**$320 billion**
End users costs savings:	**$80 billion/ year**
Benefits to economy:	**$120-150 billion/year**

Source: CENEF for the World Bank

BENEFITS

Energy efficiency is one-third the cost of building new energy supply facilities, and can be done more quickly

The forecast shortfall of natural gas production (35-100 bcm by 2010) and potential gap in additional electrical generation capacity (~20,000 MW) can be compensated by energy resources released through increased efficiency (240 bcm of gas and ~43,000 MW of electricity capacity). Russia would require investments of over $1 trillion to construct energy supply facilities to generate the same amount of energy while energy efficiency can achieve the same effect at a third of the cost.

Energy efficiency mitigates the risks and costs of Russia's high energy intensity, and will allow Russia to:

- **Maintain competitiveness:** As rising tariffs diminish the world's largest energy subsidy ($40 billion in 2005), profits of industrial enterprises will decrease by at least 15 percent. Energy efficiency will allow companies to maintain competitiveness;
- **Increase oil and gas export earnings:** Russia's energy intensity has a cost of $84-112 billion per year in terms of foregone export revenues;
- **Lower budget expenditures:** $3-5 billion can be saved annually from federal and local budgets by eliminating the inefficient use of energy;
- **Reduce environmental costs:** By ignoring the consequences of emissions caused by its energy intensity, Russia sacrifices the health and welfare of its citizens and roughly $10 billion per year in direct economic benefit from selling CO_2 emissions reduction units.

Russia can use energy efficiency to avoid becoming a CO_2 buyer

If its energy efficiency potential was to be fully realized, Russian CO_2 emissions in 2030 would be approximately 20 percent below the 1990 level. Russia's energy efficiency potential translates into a CO_2 emissions reduction of 793 million tons of CO_2 equivalent per year (about half of 2005 emissions). Not only will this contribute to addressing the challenge of climate change, but it will significantly improve Russia's international image and help Russia to reemerge as a leader in addressing global environmental issues.

CURRENT EFFORTS

Russia's energy intensity has decreased by 3.4 percent per year on average since 1990, while most former Soviet Republics achieved 6-7 percent average annual reductions for the period. The improvement in Russian energy intensity was driven primarily by a shift toward less energy intensive industries and increased industrial capacity utilization. Since most major industries were already approaching full capacity utilization as early as 2006, this will not be a major driver for reducing energy intensity in the future.

Ongoing energy sector reforms increase financially viable opportunities…

The government's liberalization of the electricity market and establishment of a set schedule for gas price increases constitute an important step toward a more energy efficient economy. For example, projected 2010 tariffs would make the financially viable[iii] energy efficiency potential almost equal to the economic potential[iv].

But only robust policy can tap Russia's energy efficiency potential

Roughly half of Russia's potential energy savings can already be achieved through financially viable investments. Yet even financially viable investments have slow uptake. For example, in the manufacturing sector, 80 percent of energy efficiency potential is financially attractive, but few companies take advantage of all those opportunities.

Current federal and regional legislation on energy efficiency is largely declarative and does not address key barriers such as lack of information and insufficient access to long term funding. Measures to remove these barriers and stimulate uptake of financially viable energy efficiency projects are essential to realizing Russia's energy efficiency potential and avoiding the consequences of continued high-energy intensity at higher tariffs.

HOW GOVERNMENT CAN INTERVENE

Strong leadership required to enable energy efficiency investment

Achieving greater energy efficiency requires that many individual decision makers gain comfort in investing their capital in projects to use energy more rationally. A strong government role can provide that comfort by removing barriers, establishing clear conditions and standards, and supplying critical information. By creating a "pro-energy efficiency" business environment, the government can catalyze significant investment flows.

Prerequisites to success: energy efficiency champion, reliable statistics

In order to ensure proper focus of purpose and resources, the government should designate a ministerial department or dedicated energy efficiency agency with the responsibility, authority and necessary funding to develop and implement a comprehensive energy efficiency policy for Russia.

This body could coordinate work with Rosstat to ensure the availability of reliable statistical information essential for understanding the current situation and monitoring the effectiveness of policy. Currently, statistical data on a number of sectors, such as buildings, heating, and transport is virtually nonexistent.

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iii An investment is financially viable if it generates attractive return under existing energy prices.

iv An investment is economically viable its value to the economy as a whole justifies the investment, e.g. the cost of saving a unit of energy is less than the cost to building a new unit of production capacity or the opportunity cost to Russia of exporting a unit of gas, whichever is greater.

Implementation options

The government should focus on the following categories of measures, each of which is necessary to achieve the full energy efficiency potential of the country. "Quick Wins" will demonstrate some rapid results and increase political support, "Essentials" will stimulate investments that are already financially viable, and "High Cost, High Return" measures will remove fundamental sources of inefficiency and will make more energy efficiency investments financially viable.

Quick Wins

These measures can be introduced in less than a year and are likely to produce significant impact at moderate cost. Some of the key solutions are listed below:

- Energy efficiency information awareness campaign
- Flexible budgeting and procurement rules in public organizations
- Transformation of municipal heat suppliers into commercial entities

Essentials

These approaches are the backbone of a comprehensive energy efficiency policy, affecting the areas of greatest potential by raising standards and enabling investment.

- Energy efficiency standards in areas such as buildings, industrial equipment, fuel efficiency
- Demand side management
- Energy efficiency as a condition for subsidy in capital renovation
- Coordinated heat supply plans
- Facilitated financing through financial institutions

High Cost, High Return

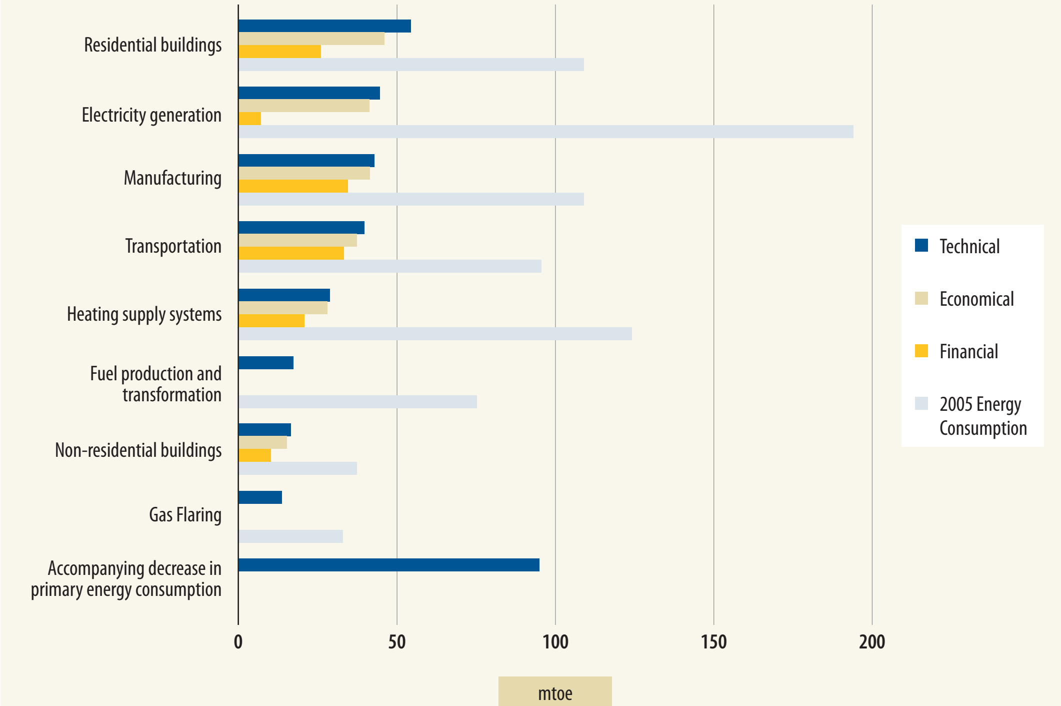
These interventions carry a much higher initial cost to the economy, but most of them have a high return in terms of energy savings as well and are critical to ensure long lasting impact and sustainability. Some of these interventions have already been initiated; others are still to be developed.

- Tariff reform
- Liberalization of electricity and gas market
- Integrated transport planning
- Charging the full cost of vehicle usage

SECTORAL REVIEW

The largest technical energy efficiency potential can be found in the residential, electricity generation, and manufacturing sectors. Figure 2 presents the energy efficiency potential by sector and indicates what level of the potential is economically attractive and financially viable.

Figure 2: Energy Efficiency Potential by Sector



Source: CENEF for the World Bank

As can be seen from Figure 2, the energy efficiency potential in end-use sectors is significantly higher than on the energy supply side. In fact, the financially viable potential in end-use sectors is four times higher than that in electricity and heat supply systems. Moreover, end-use savings are accompanied by an additional decrease in primary energy consumption (94 mtoe) across the entire energy value chain. For example 1 kWh of reduction of consumption in the residential sector will lead to a 5 kWh reduction in primary supply.

In sectors with a high level of financially viable potential (manufacturing and transportation), policy should focus on interventions that do not affect prices or offer subsidies, but remove non-financial barriers. In sectors with a low level of energy efficiency potential (electricity and heat generation), prices should be adjusted accordingly or other fiscal incentives offered to help achieve significant savings.

The summary below contains key conclusions in each sector related to energy efficiency potential, specific barriers, and required government interventions.

RESIDENTIAL BUILDINGS

Potential: -49%, 53.4 mtoe, economically viable 84%, financially viable 46%

Focus: over 70% in space heating and water heating

Incremental investment: $25-50 billion[v]

Annual energy cost savings for investors/end-users in 2007 prices[vi]: $14 billion

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[v] Including public buildings.

[vi] Here and below energy cost savings are estimated at Russia internal energy prices in 2007 benefits for the whole economy are much higher.

The most significant barriers to energy efficiency in residential housing relate to building standards, public behavior, and difficulties in organizing and financing energy efficiency improvements in common areas.

Mandating energy standards in new and renovated buildings is the most cost-effective way to ensure energy savings in the residential sector. A recent transition to voluntary building standards could undermine the progress in space heating efficiency. To be effective, building standards must be (a) mandatory, (b) regularly updated, (c) clearly enforced.

Through public awareness campaigns and by encouraging widespread use of metering, the government can influence behavior so that energy efficiency becomes a social norm in Russia. Energy efficiency improvements in common areas can be mainstreamed through the following package of interventions: (a) model performance-based management contracts, (b) a building renovation loan guarantee facility, (c) an awareness campaign to stimulate collective management of buildings.

PUBLIC ORGANIZATIONS

Potential: -42%, 15.2 mtoe, economically viable 90%, financially viable 58%

Focus: 49% in space heating

Incremental investment: see residential buildings

Annual energy cost savings for investors/end-users in 2007 prices: $3.5-5 billion

This potential is "low hanging fruit" for the government. Yet, energy efficiency improvements have limited uptake by public organizations due to the following regulatory barriers. Public organizations are not allowed to retain or reallocate savings on communal expenses, and they cannot conclude long-term contracts or contracts that pay for investments with future savings. Procurement rules favor the lowest cost of the bid, not the lowest *lifetime* cost.

By introducing flexible budgeting and/or giving public organizations autonomous status, the government can establish a fundamental incentive to save. This, however, should be accompanied by setting energy consumption targets based on benchmarking. Changes to procurement legislation that introduce multi-year contracts, performance-based contracts and the lowest lifetime cost principle are essential to allow public purchases of energy efficient goods and services.

INDUSTRY

Potential: -38%, 41.5 mtoe, economically viable 97%, financially viable 80%

Focus: 53% in ferrous metals, pulp and paper and cement, 42% in non-energy intensive sectors

Incremental investment: $35 billion

Annual energy cost savings for investors/end-users in 2007 prices: $14 billion

Industry is slow in realizing its energy efficiency potential primarily due to a lack of awareness among managers and insufficient supply of long-term capital to finance energy efficient modernization. In addition, companies in a number of sectors lack the incentive to save because energy tariffs are growing at a slower pace than product prices.

Launching targeted information dissemination campaigns and channeling long-term financing for energy efficiency investments through Russian financial institutions will help enterprises realize immediate energy saving opportunities. The continuation of electricity and gas sector reforms are important to maintain the attractiveness of energy efficiency as a business case.

Fiscal instruments such as tax rebates or accelerated depreciation could provide additional incentives in the current context to stimulate investment in new state-of-the-art equipment and management practices to produce competitive goods and services.

TRANSPORT

Potential: -41%, 38.3 mtoe, economically viable 95%, financially viable 84%

Focus: 49% in road transport, 40% in gas pipelines

Incremental investment: $124-130 billion

Annual energy cost savings for investors/end-users in 2007 prices: $20 billion

Road transport is a rapidly growing energy consumer, driven by the rapid increase in the number of private vehicles, at the expense of more efficient public transport. The quality of public transport is inadequate, and efforts are focused primarily on providing more space and roadways for use by private vehicles rather than developing public transport. In addition, private vehicle owners do not have real incentives to travel efficiently and tend to choose less efficient but cheaper or more powerful cars.

To increase the attractiveness of public transport, the government needs to introduce an integrated transport planning approach, improve the quality of public transport and enhance intermodal solutions (e.g., safe parking at rail stations). By tightening fuel efficiency standards and establishing car scrapping schemes, the government can speed up efficient renewal of the country's car fleet. Charging users the full cost of private vehicle usage through congestion road pricing and car ownership/motor fuel taxes, accompanied by improved public transportation, car labeling and public awareness campaigns, can drive the desired changes in consumer behavior.

ELECTRICITY

Potential: -31%, 44.4 mtoe, economically viable 90%, financially viable 13%

Focus: 46% in natural gas

Incremental investment: $106 billion

Annual energy cost savings for investors/end-users in 2007 prices: $8 billion

The Russian electricity sector is currently undergoing extensive restructuring. A number of positive changes have already been made, including: the unbundling and privatization of RAO-UES' assets, the establishment of an electricity market, the continued increase of tariffs to move the electric utilities closer to full cost recovery, and the commitment of the government to pilot a new tariff methodology. These reforms will all help Russia to improve its energy efficiency.

A few other barriers, however, are not currently on the government's radar screen. Firstly, the general bias in the electricity industry, perpetuated by exaggerated demand-growth projections, to build traditional, new-generation capacity rather than invest in energy efficiency. Secondly, the lack of coordination with heat supply systems and cumbersome administrative rules for small-scale CHP lead to a sub-optimal energy supply system. Thirdly, tariff methodologies currently in place discourage energy and operational efficiency behavior.

First and foremost, the government should complete electricity sector reforms, including tariff methodologies reform. The government can also introduce other measures, such as providing greater financial incentives or obligating power companies to implement demand-side management programs, as well as simplifying the rules for siting small scale CHP plants and connecting those plants to the grid.

HEAT SUPPLY SYSTEMS

Potential: -19%, 28.8 mtoe

generation: economically viable 90%, financially viable 25%

heat distribution: economically viable 99%, financially viable 92%

Focus: 55% stand for heat losses, in generation: 74% industrial boilers

Incremental investment: $18-28 billion

Annual energy cost savings for investors/end-users in 2007 prices: $7 billion

The most significant barriers to energy efficiency in the heat supply sector relate to the application of tariff methodologies, the legal structure of municipal utility providers, and a lack of sectoral information and coordination. Solutions require substantial reform of the tariffs system, transformation of municipal heat suppliers into commercial entities, better collection of statistical information, and development of a heat supply plan.

GAS FLARING

Potential: 20-38 bcm/year or 4-5% of Russia's total gas production, financially viable ~30%;

Incremental investment: n/a

Annual energy cost savings for investors/end-users in 2007 prices: $2.3 billion

The main barriers to utilizing associated petroleum gas include limited access to gas transport infrastructure, low prices for dry natural gas, low flaring penalties, and a lack of accurate information on the volume of gas flaring and utilization.

The Russian government has taken steps to increase utilization of associated gas, and additional measures are being discussed by the policymakers. However, without an overarching plan that legislates, monitors and enforces gas flaring limits while providing both rewards and penalties for compliance, the Russian government may not reach its target of 95 percent utilization by 2011.

CONCLUSION

Energy efficiency is rising to the top of the public policy agenda in Russia. Increasing energy costs are making the benefits more compelling – and the consequences of inaction more painful – than ever before.

In order to fully realize its energy efficiency potential, Russia needs a robust and comprehensive energy efficiency policy. The Russian government needs to face the challenge and focus on changing attitudes and behaviors of diverse individuals and entities. The starting point is to create and fund an "energy efficiency champion" that is empowered to formulate and implement this agenda. This will enable the government to provide effective leadership to remove both general and sector specific barriers, and create a framework conducive to public and private investment in energy efficiency improvements.

Russia has an opportunity to foster the rational use of its energy resources that will improve its economy, industrial competitiveness, and environment, establishing it as an energy superpower in the fullest sense of the word. What is required is a clear vision of the potential, an understanding of how to tap into it, and the political will to ensure that it is done properly.

1. INTRODUCTION

Energy efficiency has received very little attention in Russia until recently; now the topic seems to have the attention of leadership at the highest levels. Former President and now Prime Minister Vladimir Putin has indicated that under Russia's leadership of the G8, the summit will prioritize the topic of energy efficiency. Russia appears to be ready to consider the potential benefits of energy efficiency, and how to achieve those benefits. Shortly after his inauguration, President Medvedev made several public statements identifying Russia's inefficient use of energy, and the associated economic and ecological consequences, as one of most pressing problems facing the nation. As he acknowledged, "Our country ranks first in the world in terms of heating energy loss. This is a deplorable record. As for the level of energy efficiency, the majority of our industries are between 10 and 20 times less efficient than modern industry should be. That is why we set ourselves the goal of effectively reducing our economy's energy consumption by almost half."[1]

There may be good reasons for energy efficiency's mixed reception in Russia until recently. Messages about the importance of energy efficiency are often bundled with other agenda about the importance of liberalizing energy markets, or contributing to the fight against global warming. This paper, in contrast, focuses on energy efficiency for Russia's sake. The paper shows how improving energy efficiency can benefit Russia, and what Russia can do to ensure that it reaps the most benefits from improving energy efficiency.

The paper does include recommendations on energy sector liberalization, and pollution reduction, but only insofar as these measures directly improve Russia's national welfare. More specifically, energy sector liberalization is treated as a means to an end. Reducing pollution is treated as one of the benefits of improving energy efficiency. The analysis is structured as follows:

- Chapter 2 shows why energy efficiency matters to Russia in terms of energy security, competitiveness of the economy, fiscal strength, and human health and environment.
- Chapter 3 analyzes the extent to which Russia is energy inefficient relative to its peers.
- Chapter 4 evaluates how much Russia can improve its energy efficiency, how much of that potential is financially viable (and therefore presents an opportunity for private individuals or firms to invest), and how much of that potential is economically viable (and therefore presents an opportunity for government to invest in the interest of the country as a whole).

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1 President of Russia. Opening Remarks at the Meeting on Improving Environmental and Energy Efficiency in the Russian Economy. The Kremlin, Moscow. 3 June 2008.

- Chapter 5 analyzes why Russia has not yet realized the energy efficiency potential assessed in Chapter 4. The chapter identifies what barriers Russia will need to overcome to achieve its energy efficiency potential, and recommends what the federal, regional and municipal government can do to help remove these barriers.

The study represents 12 months of detailed, sector-by-sector analysis of energy use in Russia, and the policies, regulations, and market structures which determine that energy use. The World Bank Group (World Bank and IFC) worked closely with Russia's Center for Energy Efficiency (CENEf) to assess the potential for energy efficiency improvements in Russia, and determine possible interventions.

Russia's energy efficiency potential was assessed based on international comparisons of energy intensities of specific industries, and processes and equipment used in those industries.

Barriers and solutions were assessed based on in-depth regional studies within Russia. The team looked, in particular, at barriers to energy efficiency within Russia's regions and municipalities, and innovative solutions being used or planned to remove those barriers. International experience with energy efficiency policy was also reviewed to identify similar barriers in other countries, and identify best practices for removing barriers. In addition, a number of in-depth interviews were conducted with prominent experts in the Russian energy sector.

2. WHY SHOULD RUSSIA CARE ABOUT ENERGY EFFICIENCY?

Russia's energy intensity imposes significant costs to the country in terms of energy security, government revenues, economic output, and health and human environment; and therefore also presents significant opportunities for savings.

Achieving Russia's full energy efficiency potential would require a total of $ 320 billion in investments from private and public organizations and households. This investment would result in annual costs savings for end users of about $ 80 billion, paying back in just four years. The economy as a whole would receive substantial additional benefits from sources such as gas exports.

Energy efficiency mitigates risks and costs of Russia's high energy intensity, and will allow Russia to:

- **Ensure energy security.** Many experts see a large investment gap in Russia's oil, gas, and electricity sectors. In the face of production capacity limitations and increasing demand, reducing energy intensity will be a key factor in ensuring adequate supply. Investing in energy efficiency can achieve that reduction and can address rising demand at a third of the cost of investing in new energy supply capacity.
- **Stimulate stable economic development:**
  - **Maintain competitiveness:** As rising tariffs diminish the world's largest energy subsidy ($40 bln in 2005), profits of industrial enterprises will decrease by at least 15 percent. Energy efficiency will allow companies to maintain competitive
  - **Increase oil and gas export earnings:** Russia's energy intensity has a cost of $84-$112 billion per year in terms of foregone export revenues for the government.[2] This is roughly equivalent to 32-36 percent of the Russian government's 2008 budget
  - **Lower budget expenditures:** Over $3 billion can be saved annually from federal and local budgets by eliminating the inefficient use of energy
- **Reduce environmental costs:** By ignoring the consequences of localized NOx, SOx and particulate emissions caused by its energy intensity, Russia puts at risk the health and welfare of its citizens. By ignoring the consequences of its CO_2 emissions, Russia misses out roughly $10 billion per year in carbon credits, and risks compromising its international standing on a commitment to fighting climate change.

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2 The range depends on which gas export prices are used for the calculation. This study considered gas prices ranging from $230-350 per thousand cubic meter.

2.1 How does energy intensity affect energy security?

There are signs that Russia's energy industry is already having trouble serving the needs of domestic customers. On its current path, Russia will increasingly face the need to choose between serving Russian electric and gas customers, and gas export customers. The choice thus far has appeared to favor the more lucrative export markets. In the past several years, electric and gas customers have faced supply rationing of electricity and gas during winter months.

Russia can overcome its supply constraints by investing in new production capacity, but energy efficiency investments are a much cheaper way of meeting supply needs. Russia can invest in energy efficiency at one-third the cost of building new energy supply capacity. For every kilowatt-hour of electricity, cubic meter of gas, or barrel of oil Russia saves, it delays the need to invest in new supply capacity. Russia would need to invest at least $1 trillion to supply as much energy as it could save by investing in energy efficiency.[3] In order to reach its full potential for energy savings, Russia will need to invest only about $320 billion. More generally, the capital investments required to save 1 toe of primary energy in Russia are, on average, six-to-nine times lower than the capital investments required to build new supply capacity. Chapter 4 describes in more detail the energy efficiency investments Russia could make instead of investing in new production capacity.

The following subsections look in more detail at Russia's energy security challenges in the natural gas, electricity and oil sectors, which together supply most of Russia's energy needs.

2.1.1 Natural Gas

Some experts, including the International Energy Agency (IEA), have forecasted that Russian gas supply could, without significant additional upstream investment, fall short of projected domestic and export demand within the next few years. Russia may increasingly face the uncomfortable choice of using its gas to either serve domestic or export markets.

Russia's gas production has increased since the Russian financial crisis but is currently only slightly higher than it was in 1990. In contrast, domestic gas consumption grew on average 1.7 percent per year between 1999 and 2006 and is currently growing at 2.5 percent, despite a quadrupling in the domestic tariff for natural gas.[4] European natural gas import demand, meanwhile, is expected to continue to climb rapidly, from roughly 500 bcm to 800 bcm by 2030.[5] As domestic supply falls, Europe will need to import a much larger percentage of the natural gas it uses. The EU countries currently import roughly 50 percent of their natural gas needs, but by 2030 are expected to import 84 percent of those needs.[6] Russia currently supplies roughly 25 percent of Europe's natural gas needs. The inability to guarantee sufficient supplies was demonstrated in mid-February 2006 when Russia unexpectedly cut gas deliveries to Serbia, Bosnia and Herzegovina, Croatia, Italy, Romania, and Poland, due to lack of available gas.[7] To the extent that Russia's supply constraints continue to leave it unable to meet these growing supply needs, Europe will increasingly look elsewhere to serve its gas supply needs reliably.

3 $1 trillion in investment needs are projected for the 2005-2020 period, as estimated by CENEf for the World Bank. The number is based on international comparisons of costs. In Russia the cost is usually significantly higher.

4 IEA Energy Balance Data Set.

5 IEA.

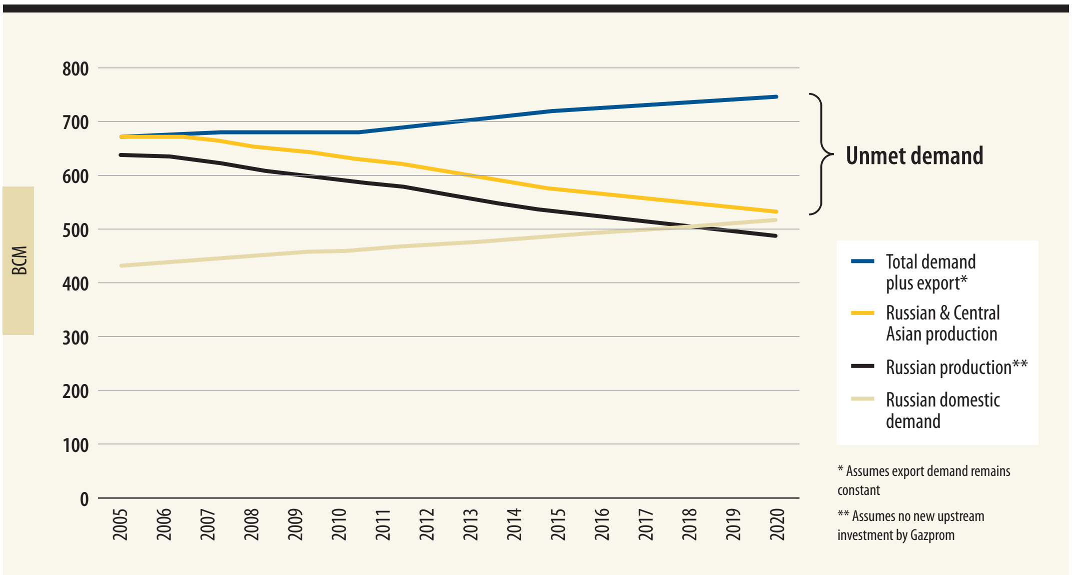
6 European Commission, Directorate-General for Energy and Transport, European Energy and Transport: Trends to 2030 – Update 2005, 2006, at http://ec.europa.eu/dgs/energy_transport/figures/trends_2030_update_2005/energy_transport_trends_2030_update_2005_en.pdf

7 Fredholm, Michael. "Natural Gas: An Expensive Trickle." TOL Special Report: Energy. Prague: Transitions Online, 2008: 19-21.

A number of experts have questioned whether Gazprom has been investing enough in new exploration, production and transport infrastructure to meet combined domestic and export demand. The Russian Energy Strategy has ambitious targets in relation to investments in the hydrocarbon sector. In the period 2000 to 2005, investments have increased, on average, 7.5 percent annually. In 2005 and 2006, the amounts directed to investment in gas production amounted to $3.5 billion and $4.8 billion. This level of investment proved sufficient to maintain existing production levels but was not sufficient to allow for major new field developments. It has been estimated that Russia will need to invest, on average, $11 billion per year over the next two decades to bring on new sources of supply and to upgrade and maintain gas infrastructure.[8]

As Figure 1 shows, the International Energy Agency (IEA) has estimated a shortfall of roughly 35 bcm by 2010 if no new upstream investments are made. According to Russia's own projections, published by the *Energy Tribune* in December 2006, gas shortfalls as large as 100 bcm are expected by 2010.[9] Gazprom's $20 billion investment program for 2007 included only $4 billion for investment in the Yamal, Shtokman, Prirazlomnoye, South Russkoye and Yamburg fields. More than half of the investment program was directed toward acquisitions of other companies and development of gas transport infrastructure.[10] If current trends continue, Russia will increasingly face the difficult decision of whether to serve export customers or domestic demand.

Figure 1: Gas demand exceeds supply of Russia's domestic and export markets



Source: IEA (2005) forecast up to 2010. Forecast after 2010 has been extrapolated from series for 2005-2010.

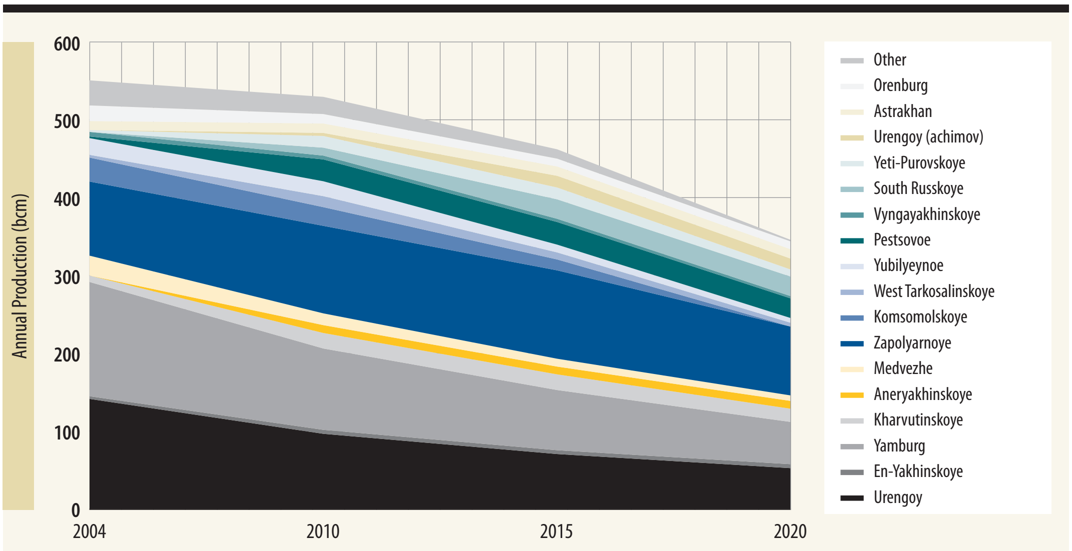
8 IEA. Reform and Climate Policy. Optimizing Russian Natural Gas. Paris: IEA, 2006: 15-16.

9 Economides, Michael J. et. al. "Gazprom: The State Within the State." TOL Special Report: Energy. Prague: Transitions Online, 2008: 22-24.

10 Based on Gazprom press release of January 16, 2007.

As Figure 2 shows, most of Russia's mature gas fields are in decline and new investment in upstream gas production has stalled. Production at Russia's three super-giant fields – Urengoy, Yamburg and Medvezhye – will decline 30 percent by 2020 (these fields together account for more than 60 percent of production). Production at Zapolyarnoye, Russia's fourth super giant field, has already peaked at 100 bcm per year.[11] Currently, Russia is able to import cheap gas from Central Asia in order to shore up any shortages in its supply, but this will become an increasingly costly alternative as both Europe and China have already begun to look to Central Asia to meet their energy needs. In addition, Central Asia has and will continue to significantly increase prices for Russia.

Figure 2: Russia's existing gas fields are in decline



Source: Jonathan Stern, Oxford Institute for Energy Studies, *The future of Russian gas and Gazprom.* 2005.

Domestic gas customers began to feel the pinch of limited supply during the winter of 2005/2006. Russia's local gas distributors had to cut five-six bcm of supply to consumers during January-February 2006. These cuts included gas supply cuts to Russian power stations of as much as 80 percent of their contractual supply volumes.[12]

11 IEA. World Energy Outlook 2006. pp. 122-123.

12 Figures from RAO UES.

Box 2.1: Gas Flaring

Gas flaring – the process of burning-off surplus combustible vapors from a well – has been singled out as one of the greatest inefficiencies in the production of oil and gas in Russia. Estimates vary as to the amount of gas flared in Russia each year. The official estimate of gas flaring in Russia in 2006 was 15 bcm/year, making Russia the second largest contributor to gas flaring behind Nigeria. President Vladimir Putin recently acknowledged that more than 20 bcm/year is being flared and, according to a recent World Bank-sponsored study, Russia flares as much as 38 bcm/year. If the study is correct, Russia flares approximately 5 percent of Russia's total gas production and 45 percent of its APG production, roughly equal to the volume of gas it sold to Germany in 2006.[13]

Gas flaring has three harmful consequences, including:

- Loss of significant economic value.
- Increased GHG emissions. Russia's flaring creates nearly 100 million tons of CO_2 emissions annually if all flared gas is efficiently burned. Russian flares are known to be inefficient which means that all of the gas flared is not burned. This releases methane (CH_4), a much more potent greenhouse gas than CO_2, into the atmosphere.
- Release of pollutants dangerous to human health. Burning APG can also release compounds of carbon, sulfur, and nitrogen, which are dangerous pollutants that are harmful to human health.[14]

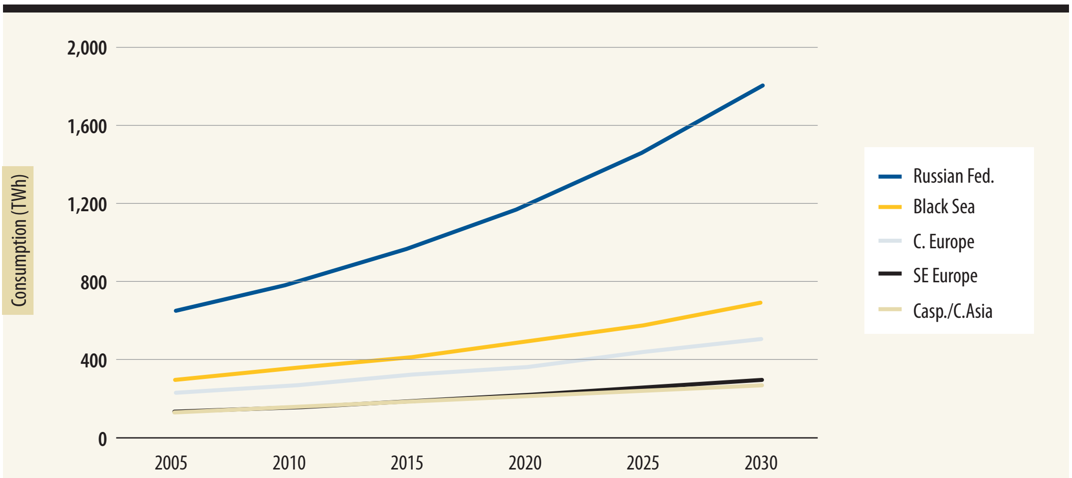
According to the World Bank-sponsored study, approximately one-third of the APG currently flared could be utilized at current APG prices. Effective utilization of this gas could result in incremental annual revenues of up to $2.3 billion and would eliminate over 30 million tonnes/year of CO_2 emissions.

Source: PFC Energy. 2007. "Using Russia's Associated Gas." Prepared for the Global Gas Flaring Reduction Partnership and the World Bank. 2-8.
BP Statistical Review of World Energy June 2007.

2.1.2 Electricity

Russia needs to add a minimum of 20,000 MW of new generating capacity over the next two-four years to meet growing electricity demand. The country will not come anywhere near this goal; having added only 1,000-2,000 MW per year in recent years.[15] Electricity consumption has been increasing at a rate of roughly 2-4 percent per year, but supply has failed to keep pace, with Russia importing roughly 200-800 MWh per month from Ukraine as of late 2006. Finland, which has been importing electricity from Russia for years is now preparing to reverse the electricity flow and become a net exporter to Russia rather than a net importer. Figure 3 shows that while electricity demand in neighboring regions will grow moderately over the next 30 years, Russia's demand will grow rapidly.

Figure 3: Russia's electricity demand growth is expected to outpace the region



Source: *World Bank Energy Flagship Study,* 2008 (Draft).

13 *BP Statistical Review of World Energy* 2007.

14 Section 2.4 contains more discussion of the harmful environmental and health effects of carbon, sulfur and nitrogen compounds.

15 Obetkon, Robert and Richard Lukas. "Russia's power sector on the threshold of an $80bn investment program." *Russian Construction Review.*

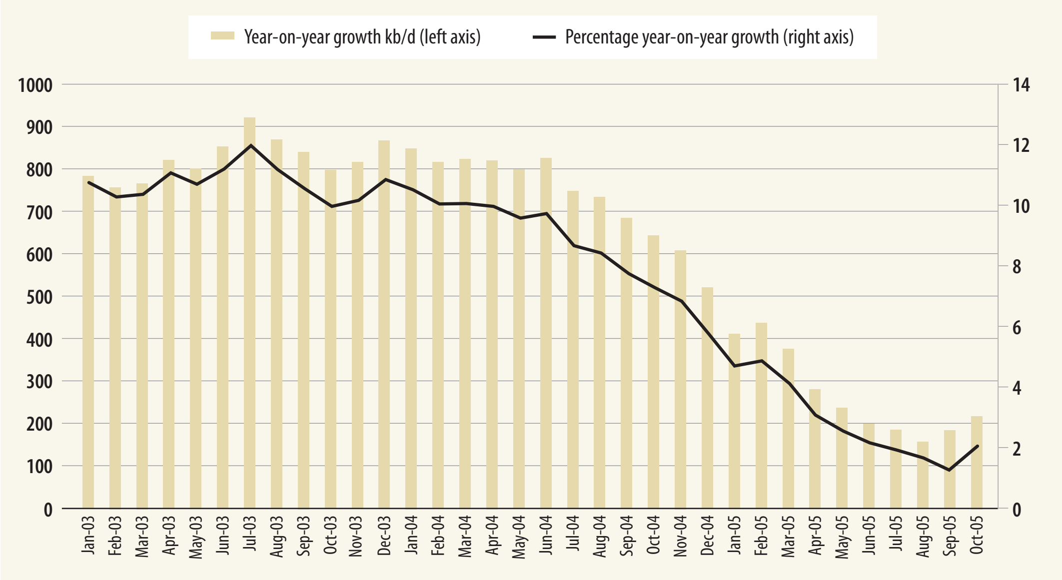
RAO UES has had to ration electricity supply in recent years. In the spring of 2005, a breakdown at the Chagino substation triggered the disconnection of 2,500 MWt of electricity capacity, equal to roughly a quarter of Moscow's consumption levels. The breakdown affected four million people, including more than 20,000 stuck in the subway, 1,500 residential buildings, and 25 hospitals. The damage to Moscow and the surrounding region of the half day outage is estimated at $90-180 million.[16] In addition, RAO cut 1.3 GW of electric power to consumers during January-February 2006, in nearly all of Russia's regions[17], driven to some extent by residential customers switching to electric heating in response to gas outages. No supply rationing was necessary during the winter of 2007/2008, helped, at least in part, by the abnormally warm temperatures.

Electricity shortages have also limited RAO UES's ability to connect new customers. The company approved only 16 percent of new connection requests in Winter 2005/2006, equal to roughly 5,000-10,000 MW of new demand.[18] 36 percent of new connection requests were approved in 2006/2007.[19] The cost of a new connection is often prohibitively expensive for most residential consumers: in many cases from $1,200 to $1,500/kW and can be as high as $4,000 in some regions.

2.1.3 Oil

The Russian government has acknowledged that Russian oil production has stagnated and oil exports are largely believed to be nearing a plateau. A top energy executive for Russia's largest independent oil company believes that Russia's oil production has already peaked and may never return to its current level.[20] Meanwhile domestic demand for petroleum products continues to increase at a robust rate. The IEA has said it expects crude output to decline as early as 2010.[21] Other sources expect that crude production may already be declining. Figure 4 shows how Russia's oil output growth declined from 2003 to 2005.

Figure 4: Slowing growth in Russian oil output



Source: IEA (2005).

16 'Rossiyskaya gazeta", 21 June 2005, 'RIA novosti' 20 June 2005.

17 RAO UES.

18 Obekton and Lukas.

19 RAO UES.

20 Hoyos, Carola and Javier Blas. "Fears emerge over Russia's oil output." *Financial Times.* 15 April 2008.

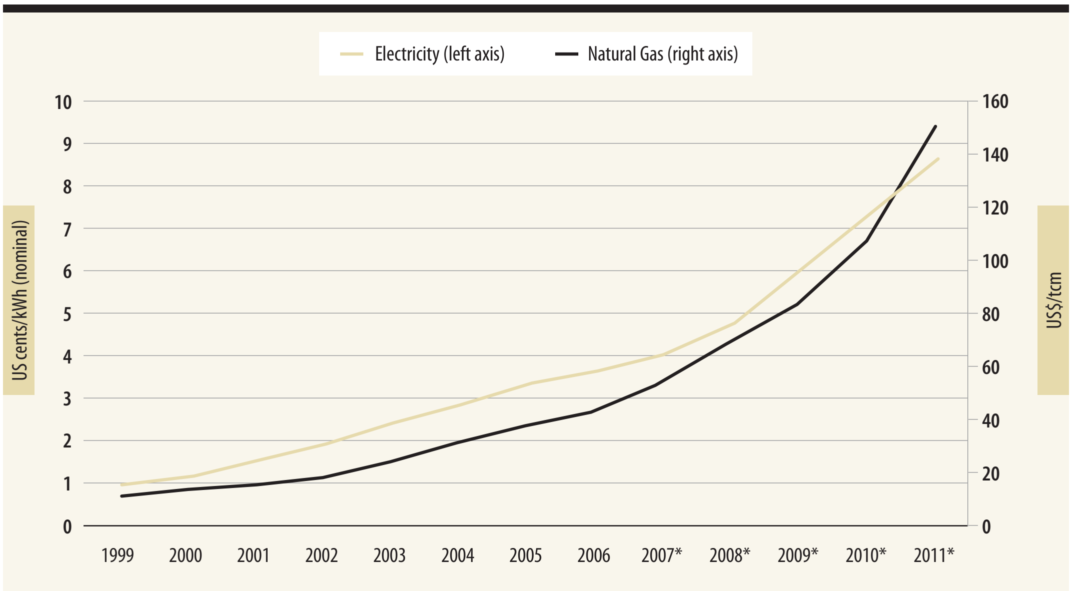
21 "Russian oil output to plateau until 2020-EconMin". Reuters. 24 July 2007.

Russia's economic growth, coupled with energy intensity and a dearth of investment in production capacity, may threaten Russia's ability to serve export markets. Indonesia and the UK provide examples of how economic growth can turn a net oil and gas exporter into a net importer. Both countries went from being major oil exporters to net importers within seven-eight years.[22] There are expectations that countries like Mexico and Iran could follow the same path. Russia's case is arguably different, because it has larger reserves, but accessing these reserves requires investment. In oil and gas production, as in most sectors, investing in energy efficiency is a less expensive way to serve incremental demand than investment in upstream production.

2.2 How does energy intensity affect economic competitiveness?

Russia's energy intensity has direct costs to the industries driving the Russian economy. Profits will decrease by at least 15 percent for Russian companies and industries that fail to mitigate the impact of tariff increases by improving their energy efficiency. Russian companies currently share in one of the world's largest energy subsidies, equal to roughly $40 billion per year.[23] The Russian government recognizes the need to raise domestic electricity and gas prices to reflect the actual long run cost of meeting demand, maintaining reliability, and operating and maintaining those assets. The government has been gradually increasing natural gas and electricity tariffs, and plans to continue to do so, as shown in Figure 5.

Figure 5: Rising electricity and gas tariffs



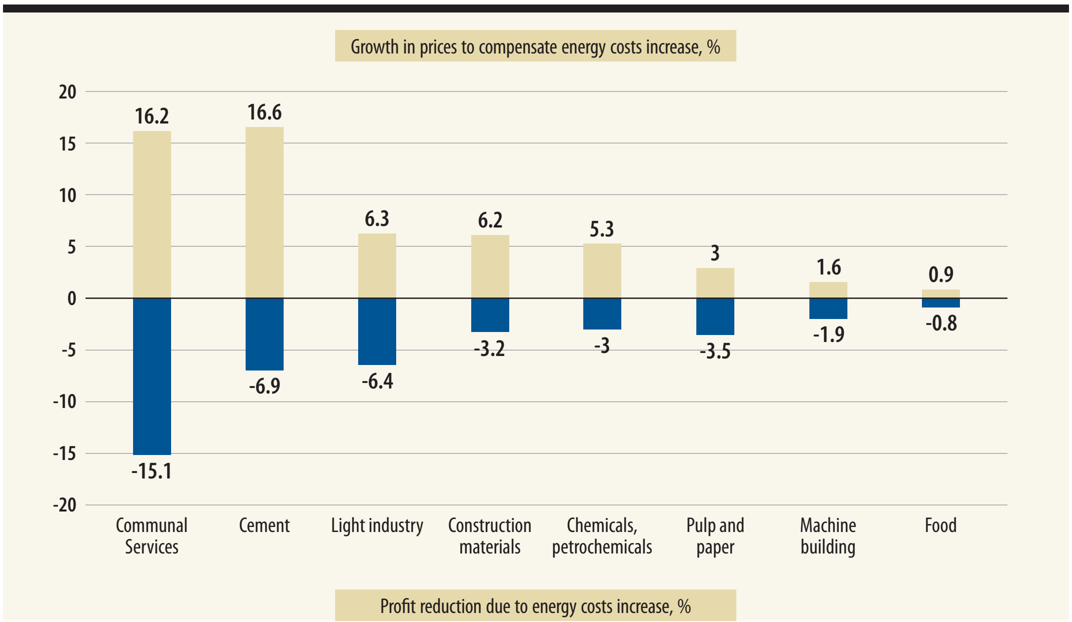
Source: FEC, FTS, Minpromenergo, and MEDIT projections for 2007-2010.

22 Brown, Jeffery J. and Samuel Foucher. "A quantitative assessment of future net oil exports by the top five net oil exporters." Energy Bulletin. 8 January 2008.

23 IEA.World Energy Outlook 2006. p. 279. $40 billion is the value of the government energy subsidy to all sectors in the economy, not just industry.

Growth in energy tariffs will increase costs and reduce the profitability of industrial enterprises. Companies will either accept a decline in profitability – some of them possibly going out of business – or compensate it with an increase in prices for their goods and services. Both options have an adverse effect on their competitive position. Estimates from the Center for Macroeconomic Analysis and Short-term Planning indicate that from 2007-2010 growth in energy costs will translate into a 15 percent (3-7 percent on an annual basis) reduction in profits. For certain industries, profits may decline by more than 25 percent. Estimated annual impact by sector is presented in Figure 6. Negative values demonstrate a reduction of profits in the respective sectors, driven by rising energy tariffs, and the positive values indicate how much enterprises will need to increase prices to compensate for rising energy costs and still maintain their current profitability.

Figure 6: Impact of energy (gas and electricity) cost increases on profits (percentage of profit, average per year in 2007-2010)



Source: Center for Macroeconomic Analysis and Short-term Planning for 'Expert' "Macroeconomic and sectoral impacts of gas price increase."

Enterprises can maintain their competitive position only by increasing labor and energy resource productivity. Industrial equipment modernization projects, witnessed by the World Bank Group, boosted energy efficiency of production and reduced specific energy consumption by 40-70 percent. Observed energy efficiency improvements have translated into a 5-7 percent profit increase, even for non-energy intensive industries.

Despite these achievements, many enterprises ignore investments that could improve their energy efficiency. At least 20 percent[24] of enterprises did not take operating and maintenance cost into account while purchasing new equipment, and another 22 percent preferred less efficient, cheaper options.

[24] IFC On the *Path to Energy Efficiency: Experience and Prospect.* Survey of 625 industrial enterprises.

2.3 How does energy intensity affect Russia's government budgets?

Russia's energy intensity has consequences for both federal and regional budgets. High energy intensity means both federal and state government budgets must devote relatively more to energy expenditure than their peers in other countries. Moreover, the federal government loses export revenue for every unit of gas or oil the country uses domestically.

Energy expenditure by state and federal governments

Government expenditure on energy has increased significantly since 2000. Federal budget funding for energy services increased from $1.14 billion in 2000 to $2.96 billion in 2005 and S$3.81 billion in 2006, constituting a three-fold increase. Of the $2.96 billion spent in 2005, $1 billion paid for electricity supply, $727 million paid for heating, $131 million paid for gas consumption, and $178 million paid for consumption of other fuels for boilers.[25] Total government budget spending, including regional and municipal budgets, on energy supply and maintenance amounts to $12.7 billion, equivalent to 1 percent of Russia's GDP.

Chapter 4 shows the technical potential for energy efficiency in Russia. If this technical potential were realized in the non-residential sector alone, budgetary expenditures on utility services would fall by $3-5 billion.[26] The majority of this savings would be achieved at the local and regional level, freeing up funding for other municipal and regional projects.

Foregone export revenue

Russia sacrifices export revenue for every 1000 cubic meters of gas export demand it cannot serve. The Russian government therefore currently loses income for every 1000 cubic meters of gas wasted in inefficient electricity production, lost in transmission and distribution, flared at oil wells, or lost through inefficient use by households. Russia could earn an additional $84-112 billion in export revenues every year by reaching its technical energy efficiency potential.[27] This figure is equal to roughly 5 percent of Russia's 2006 GDP. Oil & gas exports together currently contribute to roughly 20 percent of Russian GDP.[28] A failure to reduce energy intensity at home costs Gazprom and the government dearly.

2.4 How does energy intensity affect the environment?

Russia's energy intensity has consequences for the country's local environment, as well as the global environment. By ignoring the consequences of localized NOx, SOx and particulate emissions, Russia sacrifices the health and welfare of its citizens. By ignoring the consequences of its CO_2 emissions, Russia sacrifices direct economic benefit and international standing.

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25 CENEf for RAO UES. Analytical Note "Risks of Low Energy Efficiency," prepared under the project "Promotion of energy efficiency and energy savings in budget and communal spheres," 2006.

26 Utility services are also often referred to as "communal services" in Russia.

27 This assumptions behind this calculation are described at the beginning of Chapter 4.

28 *Russian Economic Report,* 13. World Bank. 2006.

Local Environment

There is substantial evidence of the harmful health and environmental effects of increased energy use in Russia. Industrial pollution declined with industrial output throughout much of the 1990s, but vehicle use increased. Car exhausts were estimated to account for 87 percent of air pollution in Russia in the mid-1990s. The number of vehicles on Russia's roads has increased more than 80 percent since then.[29]

A handful of pollutants, primarily PM10, SO2 and NOx, linked to fossil fuel combustion are responsible for 90 percent of human health risks from air pollution in Russia. These health risks, which increase rates of premature mortality, include: respiratory illnesses, cardiovascular disease, increased prevalence of chronic bronchitis, and upper and lower respiratory tract infections.[30] One study, based on 1993 and 1998 Rosgidromet[31] data for 178 Russian cities, estimated that 219-233 thousand premature deaths or 15-17 percent of the total number of mortality cases in Russian towns might be due to air pollution. These are aggregated numbers and pollution-related mortality rates in towns with the highest level in air pollution are believed to be much higher.[32] Another study estimated that for 1999, the mortality rate linked to air pollution was 44 persons per 100,000. Furthermore, an estimated 30 persons per 1,000 were likely to get sick due to air pollution.[33]

Another major challenge for Russia could be the potential increase of the share of coal in the fuel mix, as export markets take priority for oil and natural gas use. RAO-UES's power generation development plan to 2020 is based on new coal, hydro and nuclear, with little new oil-fired and gas-fired capacity.[34] According to one estimate, Russia is currently planning to triple the share of coal in the energy mix so that the amount of coal burnt will grow to between 150 million and 290 million tons of coal per year by 2020. A single, traditional 150-megawatt coal-fired power plant produces more than one million tons of greenhouse gas emissions per year; the amount that 300,000 cars would produce.[35] Measuring premature mortality in terms of Years of Life Lost (YOLL), a recent study estimated that such a change in the fuel mix would result in the additional loss of 118,000 YOLL Russia wide. The Central and Volga-Viatsky region could even experience additional mortality of more than 30 percent.[36] New coal generation is potentially a good option for Russia to increase its generation capacity, but care will need to be taken to identify the best clean-coal technologies to use in these new plants.

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29 Rosstat. 2006. *Main Indicators of Transport Performance in Russia*. Ministry of Transport.

30 Avaliany, S., D. Dudek, A. Golub and E. Strukova. *"Ancillary Benefits of Climate Change Mitigation in Russia." 2004. Mitigation and Adaptation Strategies for Global Change;* http://www.springerlink.com/content/b2226485v488014t/

31 Russia's Federal Service on Hydrometeorology and Environment Monitoring (Rosgidromet).

32 Reshetin, V.P and V.I. Kazazyan. 2004. "Public-health impact of outdoor air pollution in Russia." *Environmental Modeling and Assessment* 9: 43-50.

33 Bobylev S, et al. 2003. "Macroeconomic assessment of environment-related human health costs for Russia." Moscow. Working paper; citing in: Golub, A. et al. *Economic Growth, Fuel Mix and Air Quality in Russia.* Environmental Defense, Washington DC. http://www.edf.org/documents/2878_fuel-mix_05_view.pdf

34 RAO-UES. *General Scheme for Deployment of the Power Sector Entities until 2020.* Moscow. April 2007.

35 "Russia's Carbon Emissions: A Truly Burning Issue." Moscow News No. 22 2008. 6 June 2008.

36 Avaliany, S., D. Dudek, A. Golub and E. Strukova. 2004.*Ancillary Benefits of Climate Change Mitigation in Russia. Mitigation and Adaptation Strategies for Global Change;* http://www.springerlink.com/content/b2226485v488014t/

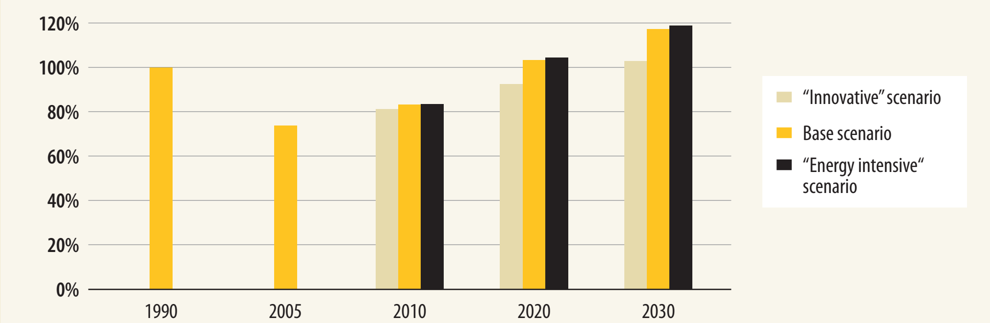
Global Environment

Russia has the potential to reduce its CO_2 emissions 793 million tons per year (about 50 percent of its 2005 emissions) by reducing its energy intensity. Reducing CO_2 emissions helps slow climate change, and has direct value to Russia through carbon credits the country can sell. At $13.70/ton, Russia's technical potential for energy efficiency reduction is worth roughly $10.2 billion in carbon credit sales annually.[37, 38] Moreover, by ratifying the Kyoto Protocol, Russia has shown a desire, unlike some of its industrialized peers, to be part of the global community's solution to climate change. Box 2.2 discusses how Russia's position vis-à-vis Kyoto targets will likely adjust during the 2008-2012 period.

Box 2.2: Will Russia be a net carbon buyer or seller after 2012?

On November 5, 2004, Russia ratified the Kyoto Protocol, and the Protocol came into force in February 2005. Russia is listed in Annex B of the Protocol and, as such, is subject to a constraint on its GHG emissions for the period 2008-2012. The target for Russia is that the country's combined emissions of Kyoto gases should not exceed five times their combined 1990 levels during the period 2008-2012. This target is generally expressed in annual terms: on average, Russia's annual emissions of the six Kyoto gases should not exceed their 1990 level – 3,048 MtCO2e – over the period 2008-2012. Since 1999, Russia's economy has grown at a pace of more than 6 percent per year, calling into question whether Russia will stay within the borders set by the Kyoto Protocol for the period beyond 2012.

Based on forecasts by international experts and by the Russian Ministry of Economic Development (MED), there is almost no chance that Russia's emissions will exceed the limits set by the Kyoto Protocol. The table below – based on figures from the MED – shows that even in the most pessimistic scenario (dark column) the emissions would only in the year 2020 increase beyond the limits set for 2012.



Russia will, and perhaps has already seen, the impact of climate change. Opinions and evidence on the impact of climate change for Russia vary. Many believe, and some studies support the idea that climate change will benefit Russia because warmer temperatures will mean increased productivity of land, and access to the northern regions that are currently covered with ice. On the other hand, climate change in Russia may also bring with it new diseases, infestations, harmful climatic anomalies, and decreases in agricultural productivity which offset the advantages of access to more arable land.[39] A recent World Bank study found that by 2020, productivity levels will decrease in 9 out of 13 regions in Russia as a result of climate change. Table 2.1 describes some of the effects experts believe climate change has already had, or may eventually have, in Russia.

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37 €10/ton was used as the price of carbon for the purpose of this analysis. At the time this analysis was conducted (autumn 2007), €10/ton was equivalent to $ 13.70/ton. By the time this study was ready for release (Summer 2008), the US dollar price of carbon was been considerably higher because of the US dollar's depreciation.

38 This excludes the potential benefit of reducing gas flaring. However, if Russia starts to aggressively sell carbon credits, the price could go down considerably and have an adverse effect on CDM prices for developing countries.

39 Kokorin, Alexey. Report No. 2: Expected Impact of the Changing Climate on Russia and Central Asia Countries. World Bank. Moscow: 2008.

Table 2.1: Climate Change Effects and Impact in Russia

Climate change effect	Potential impact in Russia	Examples of demonstrated and expected effects
POSITIVE EFFECTS		
Higher temperatures	Warmer winters.	Agricultural vegetation period could increase to be 5-10 days longer than it is currently. Suitable land and production potentials for cereals could marginally increase in Russia.
		A decrease in the number of frost days and a rise in the average winter temperature will smooth out winter consumption of electricity and reduce heating demand.
Loss of sea ice	Increased commercial shipping.	Vilkitsky Strait bottleneck will likely open for shipping for 120 days per year instead of the current 20-30 days.
Permafrost melting	Decreased flooding in some areas.	Melting may improve drainage conditions and lead to a decrease in the groundwater content in some areas.
NEGATIVE EFFECTS		
Higher temperature	Thawing roads decrease winter road use accessibility for forest logging, oil, gas and mining transportation.	Winter roads cannot be improved for use in non-frost periods due to their location in marshes and wetlands. The warm winter of 2006/2007 caused problems in several Russian European regions, in particular in Kostroma Oblast, where large logs were left to decay in forests. Decreased access to roads will increase maintenance costs and make the region less attractive to developers.
	Evaporation causes increased risk of forest fires.	Frequent fires are a serious problem, especially in Eastern Siberia and Far East. In the next 10 years, increased evaporation will prolong the period of a high risk of fire by 5 days.
Permafrost melting	Damage to building infrastructure.	Permafrost melting is relevant to 60 percent of Russian territory and will have serious implications for building infrastructure. In 2006 in Yakutsk, many cars suddenly slid into a huge hole of unfrosted mud. In the last 30 years in Yakutsk permafrost melting caused damage to more than 300 buildings, a power station, and a runway at Yakutsk Airport.
	Increased risk to oil and gas pipelines.	Many oil and gas pipelines are located in areas subject to freeze-thaw permafrost processes, increasing the potential for accidents and spills.
Increase in duration of hot weather period, including heat-waves	Expansion of infectious and tropical (southern) diseases.	There are 50 times more ixodidae ticks and the illness rate is 40 times larger than it was 45 years ago. The summer of 2007 broke the record for the rate of tick-born encephalitis infections in Russia.
	Direct negative influence on human health.	In Moscow, as a result of a heat wave, the mortality rate for July 2001 was 93 percent higher than average.
	Impact on agriculture. Losses in grassland vegetation. Risk of pests and disease outbreaks.	Total losses of cereals productivity in Russia as a whole could be about 11 percent by 2015 and up to 20 percent and more by the middle of the 21st century, if adaptation measures to resist dryness are not undertaken in the main agriculture regions of the country
Changes in precipitation: Drought	Impact on agriculture. Decrease in yield in middle and long-term perspective.	Total losses of cereals productivity in Russia as a whole could be about 11 percent by 2015 and up to 20 percent and more by the middle of the 21st century, if adaptation measures to resist dryness are not undertaken in the main agriculture regions of the country
Changes in precipitation: Floods	Damage to settlements, roads, and infrastructure.	Localized floods have increased in downstream towns due to faster snow and ice melting. In 2001 in the upper Lena River, fast snow melting, ice crushing, and the forming of an ice dam below the city lead to a 20 m growth in the water level. Fifty-nine settlements and 8,500 houses were damaged and 39,000 people were injured very seriously. In the city, 80 percent of houses were lost.
Loss of sea ice	Disrupt commercial ship transportation.	Glacier decomposition will cause drifts of huge ice fields over hundreds of kilometers, crucially increasing the risk for shipping and oil or gas platforms.
	Wildlife disrupted (e.g. Polar Bear and Walrus dependent on sea ice)	Absence of ice will undermine the food supply chains and lifestyles of polar bears, walruses and other marine animals.

Sources: The World Bank. 2008. *Europe and Central Asia Region: How Resilient is the Energy Sector to Climate Change?* and Kokorin, Alexey. 2008. Report No. 2 *Expected Impact of the Changing Climate on Russia and Central Asia Countries.*

In addition to the direct effects of climate change in Russia, global warming in other parts of the world could have significant negative political repercussions for Russia. Such repercussions could include increased immigration, increased risk of conflict, and less access to resources and raw materials (for example, in parts of Africa where Russia's energy industry is now expanding).

3. IS RUSSIA ENERGY INEFFICIENT?

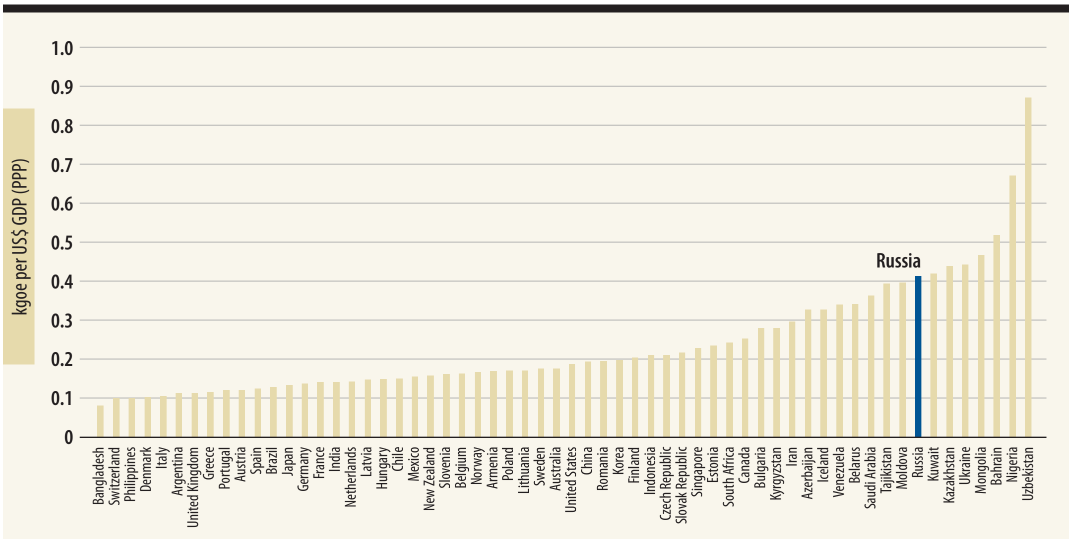
Russia is the world's third largest energy consuming country, yet consumes more energy per unit of GDP than any of the world's 10 largest energy consuming countries. In 2005, Russia's energy consumption ranked it 12th out of 121 countries in terms of kilograms of oil equivalent (kgoe) per US dollar of the country's GDP. Russia's energy intensity has decreased since 1990, but much less so than most former Soviet Republics. Instead, high energy intensity remains endemic to every sector of the economy.

With the world's largest land mass, centers of population in some of the coldest areas on earth, the world's 10th largest economy, and a predominance of heavy industry, it is understandable that Russia will be at the higher end of any international ranking of energy intensity. Collectively, however, these factors fail to explain all of Russia's energy intensity. Russia remains more energy intensive than international comparisons would suggest for countries with its level of income, land mass, temperatures, and industry structures.

3.1 Is Russia less energy efficient than other countries?

Russia is one of the world's most intensive users of energy by any aggregate measure. In 2005, measured in terms of economic output, Russia's energy consumption was equal to 0.42 kilograms of oil equivalent (kgoe) per U.S. dollar of the country's GDP, ranking it 12th out of 121 countries by that measure. Figure 7 shows how Russia compares to other countries in terms of energy consumption per U.S. dollar of GDP.

Figure 7: Global Comparison of Energy Intensity per GDP (PPP)



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP and PPP conversion factor data from the World Bank Development Indicators Database.

Of the world's 10 largest energy consuming countries, none consumes more energy per unit of GDP than Russia. Table 3.1 shows how Russia compares to these other large consumers.

Table 3.1: Energy Intensity of Top 10 Energy Consuming Countries in 2005

Country	Total energy consumption (million toe)[40]	Energy Intensity	Ranking
		kgoe per GDP	in terms of kgoe per GDP (PPP)*
United States	2,340.29	0.19	58
People's Republic of China	1,717.15	0.20	55
Russia	646.68	0.42	12
India	537.31	0.14	87
Japan	530.46	0.14	92
Germany	344.75	0.14	90
France	275.97	0.14	88
Canada	271.95	0.25	33
United Kingdom	233.93	0.12	101
Korea	213.77	0.20	53

* Out of 121 countries

Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP and PPP conversion factor data from the World Bank Development Indicators Database.

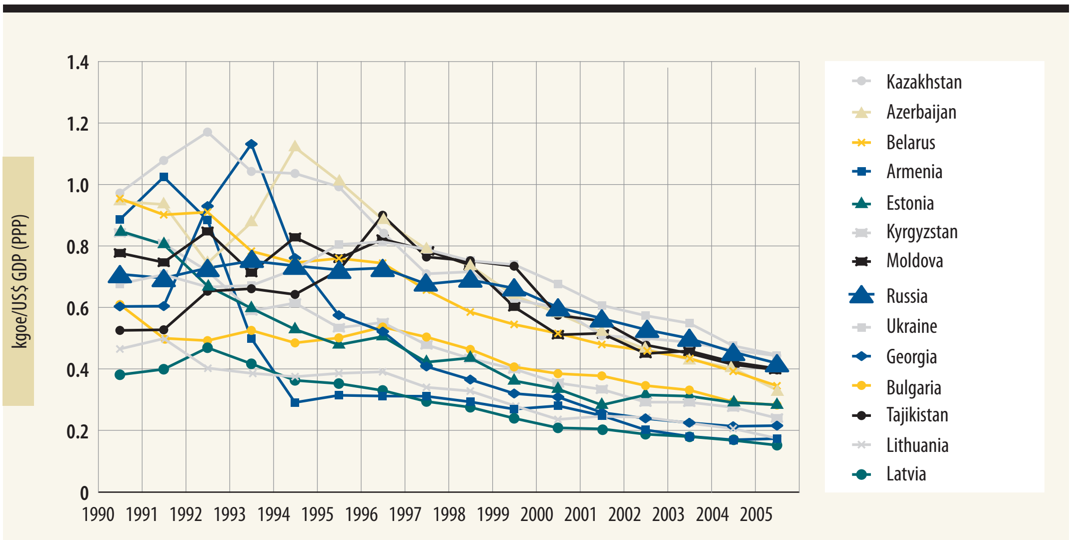
Russia's energy intensity has decreased over the past 15 years, but much less than most former Soviet Republics.[41] Russia's energy intensity has decreased by roughly 3.4 percent annually. Only Ukraine and Tajikistan have seen slower reductions in energy intensity, at annual rates of 2.7 and 1.8 percent, respectively.[42] Meanwhile, the Baltic states, Belarus, Bulgaria, Kazakhstan, Kyrgyzstan, have all reduced energy intensity in the range of 5-8 percent per year. Of the former Soviet Republics, Russia has gone from being roughly middle-of-the pack in terms of energy intensity, to one of the most energy intensive. Figure 8 shows the energy intensities for other former Soviet Republics during 1990-2005.

40 We distinguish "total energy consumption" from "end-use energy consumption". "Total energy consumption" in this table, and throughout this paper includes both end-use energy consumption – referred to as "Total Final Consumption" in the IEA's accounting of energy balances – as well as energy consumed in the transformation of one form of energy to another (for example, natural gas used in electricity production).

41 A decline in energy intensity can of course be driven by a decrease in energy consumption relative to GDP, or an increase in GDP relative to energy consumption. Energy consumption decreased in only 28 of 138 countries between 1990 and 2005. Fourteen of the 15 former Soviet Republics fall within this group, as do former COMECON members Albania, Bulgaria, the Czech Republic, Hungary, Mongolia, Poland, Romania and the Slovak Republic. Energy consumption has grown slightly in only one of the 15 Republics, Uzbekistan. Another former COMECON member, Cuba, also saw energy consumption decrease, as did three states of the former Yugoslavia (an associate COMECOM member). Energy consumption has also decreased in Germany and North Korea.

42 Sufficient data were not available to calculate the growth rate for Turkmenistan. Ukraine, and Tajikistan, unlike Russia, have both seen negative GDP (PPP) growth rates, meaning the effect of decreased energy consumption dominates the decrease in energy intensity.

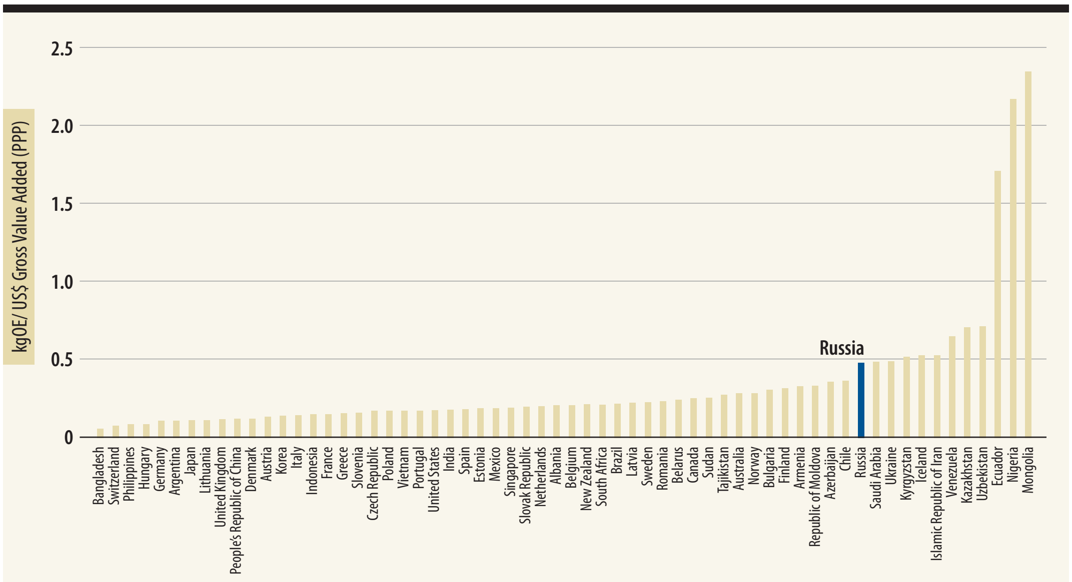
Figure 8: Russia has become one of the more energy intensive countries of the former Soviet Union



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP and PPP conversion factor data from the World Bank Development Indicators Database.

Energy intensity is endemic to every sector of Russia's economy. Russia ranks among the top 25 energy intensive countries in seven major areas of economic activity: agriculture, hunting and forestry; construction, manufacturing; transport, storage and communications; wholesale, retail trade, restaurants and hotels; and other activities. Only Uzbekistan shares this distinction. Figure 9 shows how Russia compares to other countries in energy intensity of manufacturing. Appendix A shows how Russia compares to other countries in six other sectors.

Figure 9: Comparison of Global Energy Intensities of Manufacturing



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

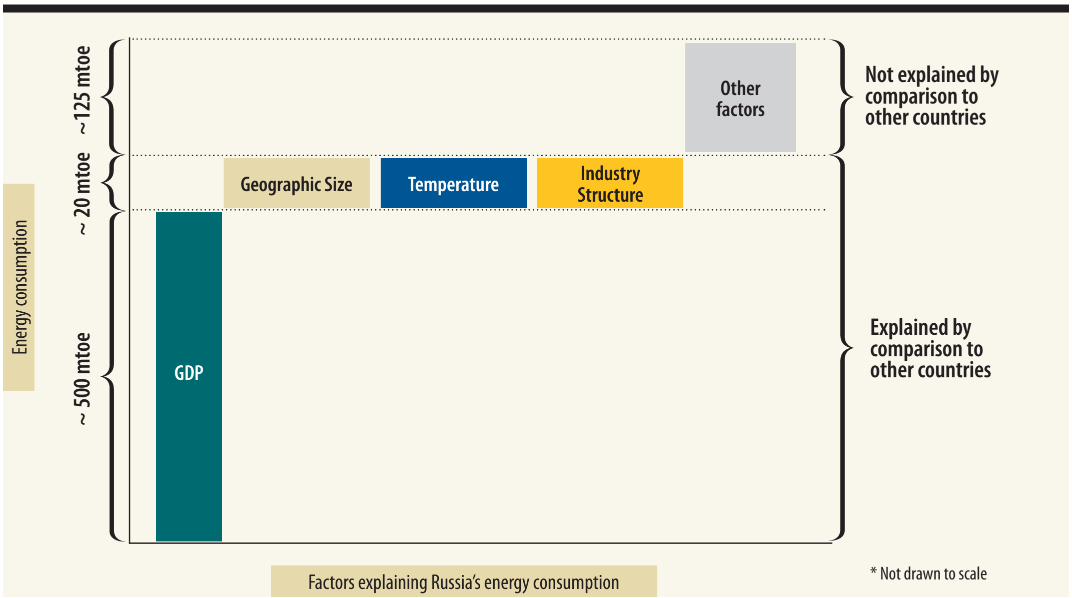
3.2 How much less efficient is Russia than its closest peers?

Levels of income, geographical size, temperature, and industry structure together describe some of Russia's appetite for energy, but not all of it. Temperature, land mass, and industry structure, in particular, are often cited as explanations of Russia's relatively higher energy intensity. These explanations clearly have merit, because Russia is unique in having the world's second coldest average temperatures, the world's largest land mass, and the most highly industrialized economy in the former Soviet Union. However, these factors collectively do not explain the full extent of Russia's energy intensity.

In general, the larger a country's GDP, the greater its surface area, the lower its average temperature, and the larger portion of economic output produced by industry, the higher will be a country's energy consumption. These factors together explain most of the differences between countries' levels of energy consumption. However, they appear to explain only around three-quarters of energy consumption in Russia. In other words, Russia's energy consumption is roughly 25 percent higher than a comparison with other countries would predict.[43] Reducing energy consumption by 20 percent will therefore put Russia on par with the international average for energy intensity. Chapter 4 shows how Russia can achieve and surpass this potential and how much Russia will save by becoming a leader in energy efficiency.

Figure 10 shows a stylized estimate of the extent to which various factors determine the differences in energy consumption between countries, and the extent to which these factors explain energy consumption in Russia. As the figure shows, at least some of Russia's energy consumption is due to factors other than income, size, temperature, and industry structure. As the analysis in Chapters 4 and 5 suggest, there are other factors – many within the immediate control of Russia's policymakers and investors – which may be driving Russia's energy intensity.

Figure 10: Weight of various factors in determining Russia's energy intensity



Source: Based on a series of econometric analyses undertaken by the study team, and subjective expert assessments. The following data sets were used: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set; GDP and PPP conversion factor data from the World Bank Development Indicators Database; Temperature data from data set TYN CY 1.1, Mitchell, T.D., Carter, T.R., Jones, P.D., Hulme,M., New, M., 2003: "A comprehensive set of high-resolution grids of monthly climate for Europe and the globe: the observed record (1901-2000) and 16 scenarios (2001-2100)". Journal of Climate: submitted; Gross Value Added data (by sector) from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

[43] Based on a series of econometric analyses undertaken by the study team. Data sets used are cited below in Figure 10.

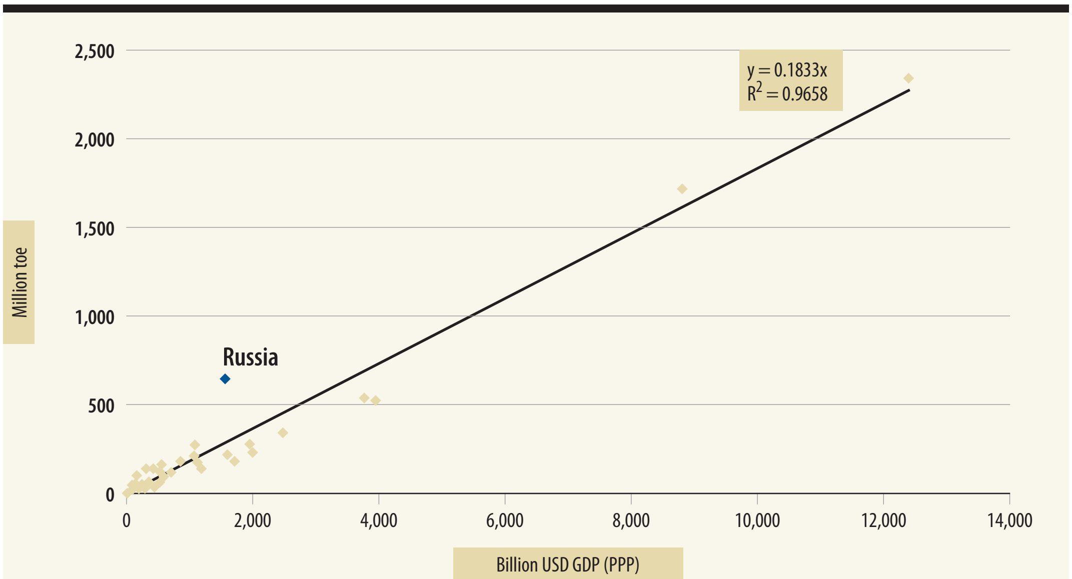
Russia's economic output, surface area, temperatures, and industry structure together predict a level of energy consumption closer to Japan's or India's. At such levels of energy consumption (holding GDP constant) Russia's energy intensity would be 0.34 kgoe/GDP instead of 0.41 kgoe/GDP; closest to the energy intensity of Iceland and Saudi Arabia, rather than (as currently) the Democratic Republic of Congo, Mozambique, or Kazakhstan.

The following subsections look briefly at how Russia compares in terms of energy intensity to other countries that share some of the economic and physical characteristics mentioned above.

3.2.1 Income

A simple analysis of the correlation between energy consumption and the factors listed above suggests that a good determinant of energy intensity in any country is GDP.[44] As Figure 11 shows, a high correlation exists between countries' total energy consumption and their PPP-weighted GDP. As Figure 11 also shows, however, Russia is a clear outlier in this correlation. Russia is the world's tenth largest economy, but its third largest energy consumer. Russia's energy consumption is more than three times that of its closest peers in terms of GDP, Spain and Brazil.

Figure 11: Correlation of Energy Consumption to GDP (PPP), 2005



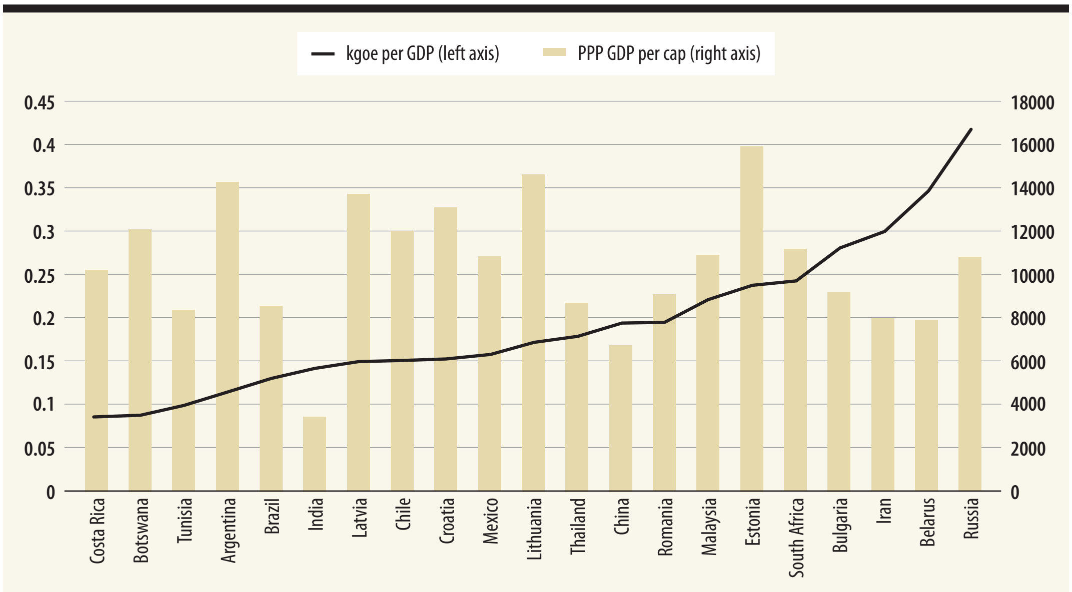
Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP and PPP conversion factor data from the World Bank Development Indicators Database.

Russia also appears to be far more energy intensive than countries with similar GDP per capita. Russia's per capita income in 2005 (roughly $10,000 per year in PPP terms) was closest to Mexico's but had twice the level of energy consumption per capita. Russia is also more than twice as energy intensive as the next most energy-intensive BRIC country, China, in terms of energy consumed per unit of GDP, and nearly four times as energy intensive as China in terms of energy consumption per capita.[45]

[44] This study chose to analyze the correlation between GDP and energy consumption, rather than between GDP and energy intensity. Energy intensity, when measured on a per capita basis, shows a high correlation to GDP per capita, but the correlation is likely overstated because GDP per capita shares a common numerator and denominator with both measures of energy intensity, namely, GDP per capita and kgOE per USD GDP.

[45] A 2001 Goldman Sachs report coined the acronym BRIC (Brazil, Russia, India, China). The BRIC countries are large developing countries, in terms of population and land mass, which Goldman Sachs speculated would become major economic forces during the early decades of the 21st century. (Goldman Sachs, Global Economics Paper

Figure 12: Energy Intensities of BRIC Countries and Countries with Similar GDP per Capita

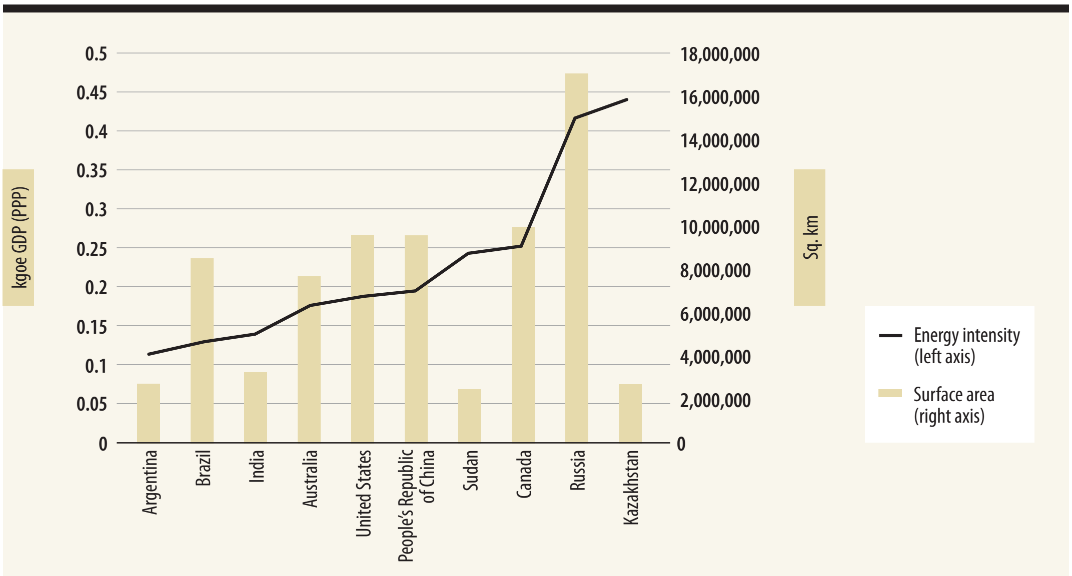


Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP, PPP conversion factor, and population data from the World Bank Development Indicators Database.

3.2.2 Surface Area

Russia's geographic size also appears to explain a portion of the country's energy intensity. Figure 13 shows the correlation between select countries' surface areas and their energy intensities.

Figure 13: Energy Intensities of Countries with large surface area



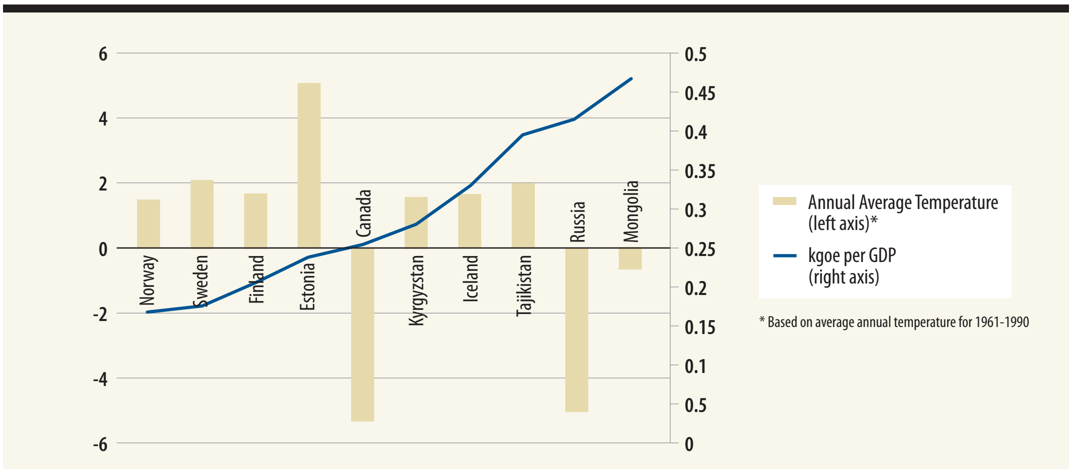
Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP, PPP conversion factor, and surface area data from the World Bank Development Indicators Database.

No. 66. Building Better Global Economic BRICs, 2001). The lower energy intensities in the other BRIC countries may be due, at least in part, to the fact that these countries have lower proportions of their populations connected to electric and gas networks than Russia.

3.2.3 Temperatures

Temperatures appear to explain some, but relatively less, of Russia's energy intensity than might be expected. Russia is, on average, one of the world's coldest countries, and much of its population lives in areas far colder than the populations of countries at similar latitudes.[46] Colder climates undoubtedly require more energy for heating and arguably also require more energy to produce the goods and services necessary to withstand cold temperatures. Figure 14 shows the energy intensities of the 10 countries with average temperatures closest to Russia's. As one of the coldest, Russia is also one of the most energy intensive, but the relationship between temperature and energy intensity is not clear for all countries. Notably, Canada, which has colder average temperatures than Russia, has much lower energy intensity.

Figure 14: Energy Intensities of Countries with Similar Average Temperatures

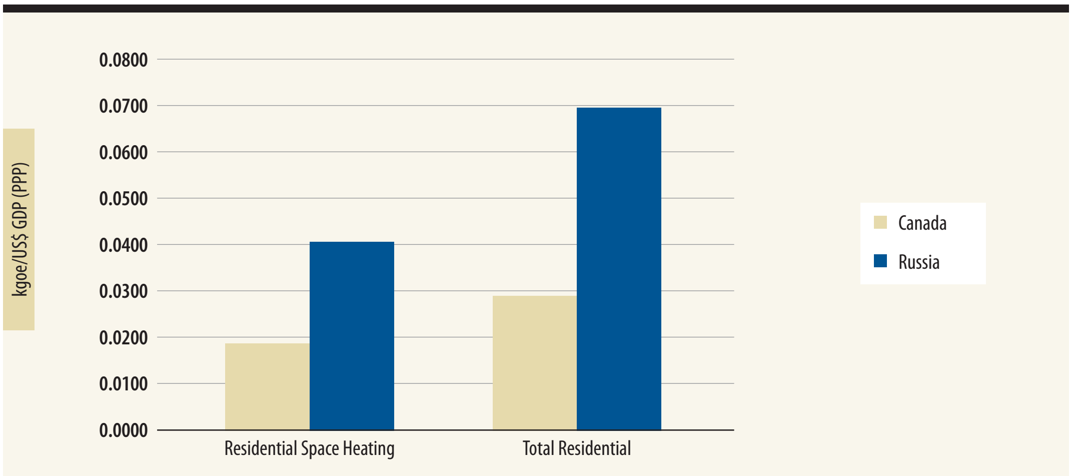


Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP and PPP conversion factor data from the World Bank Development Indicators Database. Temperature data from data set TYN CY 1.1, Mitchell, T.D., Carter, T.R., Jones, P.D., Hulme,M., New, M., 2003: "A comprehensive set of high-resolution grids of monthly climate for Europe and the globe: the observed record (1901-2000) and 16 scenarios (2001-2100)". *Journal of Climate:* submitted.

Because Russia is closest to Canada in terms of average annual temperatures, it is worth comparing the countries in terms of energy intensities, specifically in the residential sector, and specifically with regard to heating energy use. The figure below shows this comparison.

46 Two recent books have attempted to make the case that Russia's climate differentiates it from the rest of the World: *The Siberian Curse* by Fiona Hill and Clifford Gaddis (2003, The Brookings Institution), and *Why Russia is Not America,* by Andrey P. Parshev ("Pochemu Rossiya ne Amerika: kniga dlya tekh, kto ostayetsya zdes'. Moscow: Krymskiy Most-9D, Forum, 2000. Hill and Gaddis remind their readers that isotherms, not latitudes, matter more in determining temperature. Temperatures drop in Russia as one moves east of Moscow to Russia's other large cities. They also argue that Russia is more energy intensive than its latitudinal peers because of the way in which population is distributed. Populations in Canada and the Scandinavian countries live along their southern borders whereas Russia's population is distributed – as part of a deliberate effort by Soviet central planners – eastward and northward toward colder temperatures.

Figure 15: Energy intensity of residential energy consumption and heating in Russia and Canada

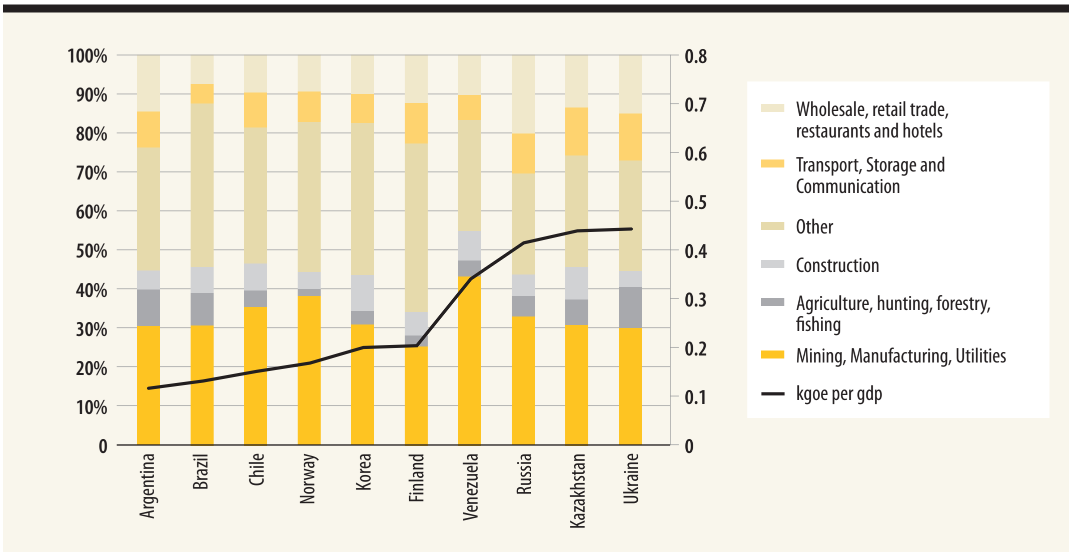


Source: IEA Energy Balances, CENEf for the World Bank, and Natural Resources Canada.

3.2.4 Industry structure

Predominance of heavy industry also undoubtedly has some impact on a country's energy consumption. Much of the value of Russia's economic activity (roughly one-third) comes from heavy industry, which is generally more energy intensive than other economic activities such as agriculture, or wholesale and retail trade. As Figure 16 shows, however, Russia is more energy intensive than most of its peers with similar industry structures.

Figure 16: Energy Intensities in Countries with Similar Economic Structures (2005)



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. GDP and PPP conversion factor data from the World Bank Development Indicators Database. Gross Value Added data from UNDP National Accounts data set.

4. BY HOW MUCH CAN RUSSIA REDUCE ITS ENERGY INTENSITY?

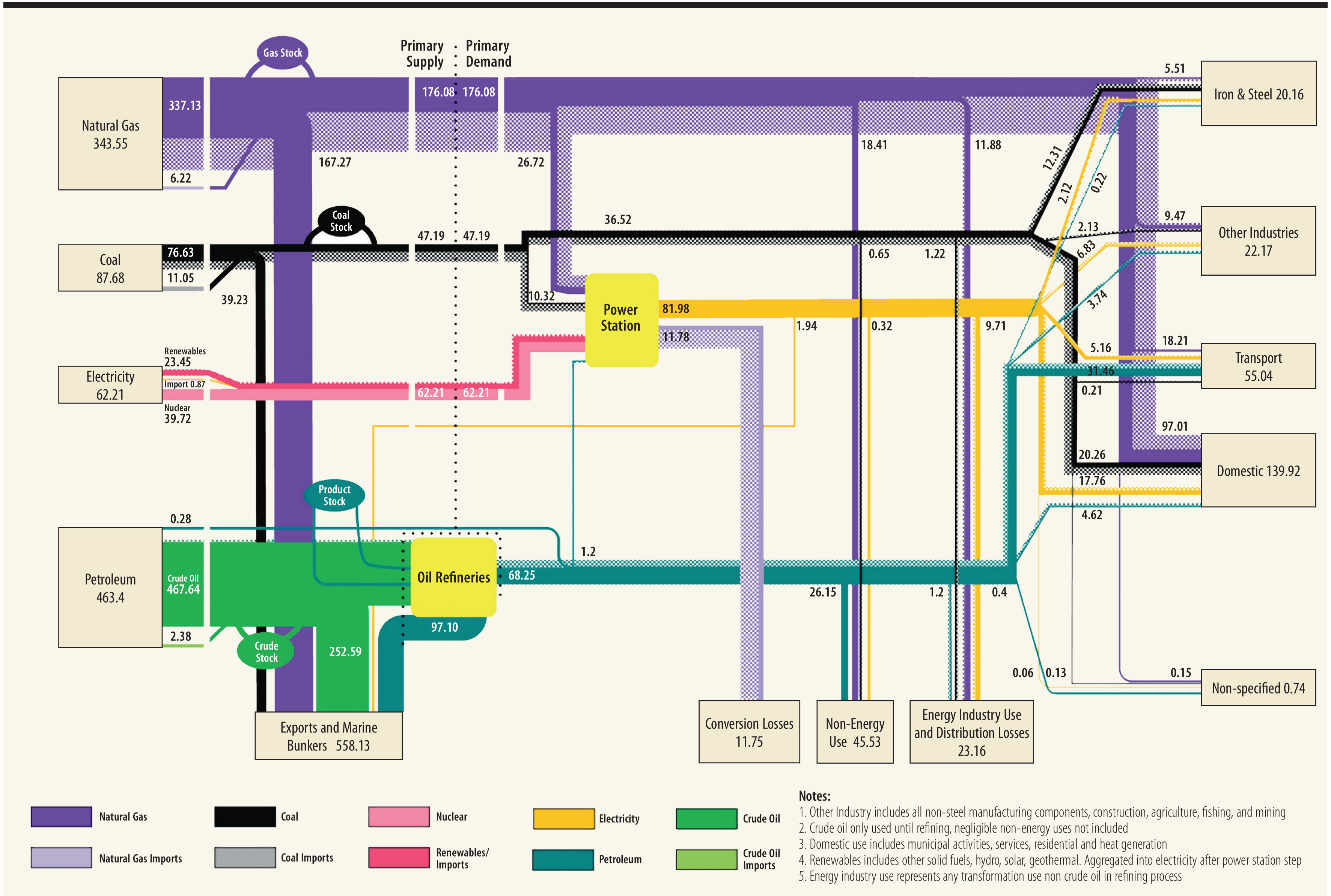
Russia can cut its total energy consumption by 45 percent. Such a reduction includes:

- 240 bcm of Russia's largest fuel source, natural gas,
- 340 billion kWh of electricity,
- 89 million tons of coal, and
- 43 million tons of crude oil and crude oil equivalents in the form of refined petroleum products.

In total, Russia can achieve energy savings equivalent to roughly 300 million tons of oil per year, or 2.1 tons of oil per inhabitant. This level of savings is equivalent to all energy produced and imported (net of exports) by countries like France or the United Kingdom, or 2 percent of all energy produced in the world in 2005.

The largest reductions in end-use energy consumption are achievable in residential energy consumption (53.4 mtoe), electricity generation (44.4 mtoe), manufacturing (41.5 mtoe), transport (38.3 mtoe), and heat supply systems (31.2 mtoe). Figure 17 shows Russia's energy flows, and how those flows would change if Russia were to achieve its technical potential for improvements in energy efficiency. The checkered portions of the energy flows indicate the extent to which consumption of each fuel could be reduced. Appendix B contains the full 2005 integrated fuel and energy balance used as a baseline for estimates of energy efficiency.

Figure 17: Energy Efficiency Potential in Russia – Changes in energy flow



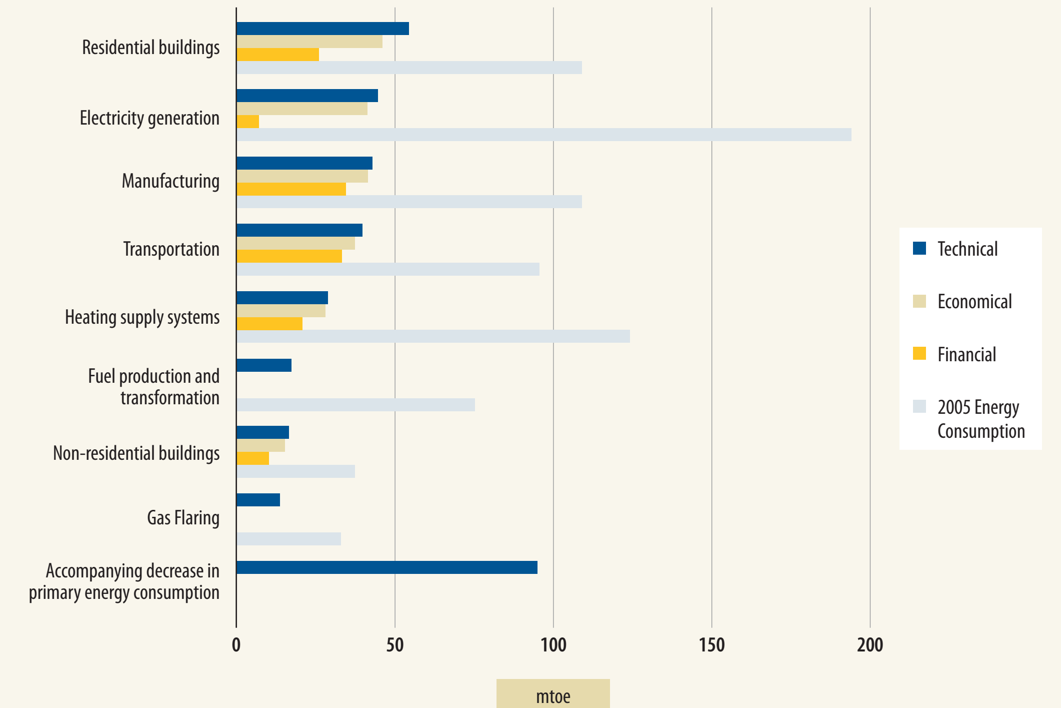
Notes:

1. Other Industry includes all non-steel manufacturing components, construction, agriculture, fishing, and mining
2. Crude oil only used until refining, negligible non-energy uses not included
3. Domestic use includes municipal activities, services, residential and heat generation
4. Renewables includes other solid fuels, hydro, solar, geothermal. Aggregated into electricity after power station step
5. Energy industry use represents any transformation use non crude oil in refining process

Source: CENEf for the World Bank. Energy Flow Diagram developed by the UK's Department of Trade and Industry (now Department for Business Enterprise and Regulatory Reform)

Investments in energy efficiency can save Russia energy directly, by reducing total final energy consumption, and indirectly, by reducing the volume of fuel required to transform and transport energy for end use consumption (primary supply). For example, a reduction in household electricity consumption reduces the fuel generators must use to serve load. The less fuel generators burn, the less fuel that needs to be extracted and transported (whether by pipeline, rail, or road), and the less energy that needs to be spent extracting that fuel. In Russia, a reduction in electricity consumption reduces overall energy sector consumption nearly five-fold; a reduction in heat consumption reduces overall energy sector consumption by nearly three-fold. Figure 18 shows the end-use energy efficiency potential in each of Russia's major consuming sectors, and the accompanying reduction of primary energy consumption brought about by reductions in final energy consumption.[47] The large accompanying decrease in primary energy consumption (94 mtoe) further demonstrates why Russia should focus on achieving energy savings in end-use consumption.

Figure 18: Energy Efficiency Potential by Sector and the Multiplier Effect

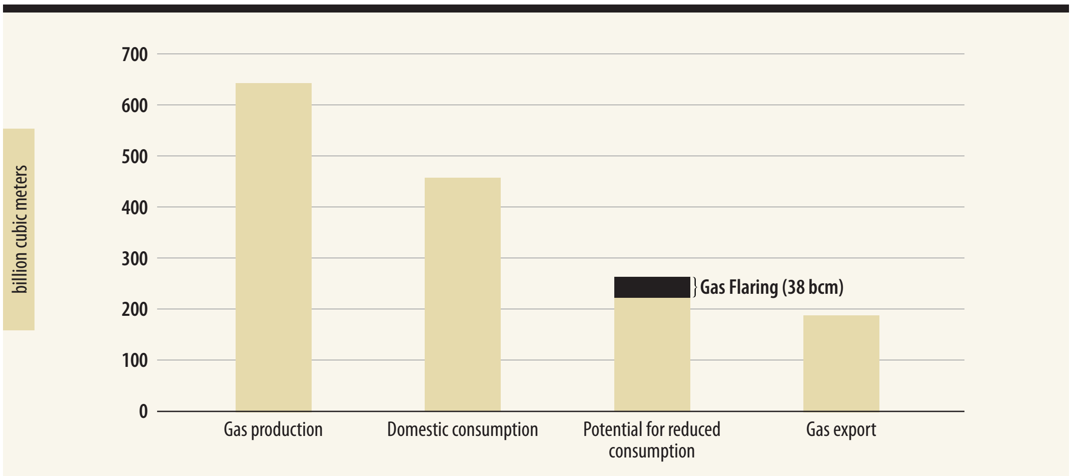


Source: CENEf for the World Bank. Statistical data on the economic and financial viability of fuel production and transformation and gas flaring is currently unavailable.

Most of Russia's energy savings potential lies in reducing natural gas consumption. Figure 19 shows the potential for gas savings in Russia through energy efficiency investments, as compared to gas production, domestic consumption, and export.

[47] Appendix B contains a more detailed discussion of how these multipliers are calculated.

Figure 19: Gas savings potential in Russia



Source: CENEf for the World Bank.

Most of the investments required to reach Russia's total energy savings potential will save money, as well as energy. Three-quarters of Russia's potential for energy savings can be achieved through investments that are economically viable. In other words, the value of energy savings to Russia as a whole outweighs the cost of investment. Roughly half of Russia's potential energy savings can be achieved through investments that are financially viable. In other words, households, companies, and government agencies would save money and energy by making these investments.

The remainder of this chapter analyzes in more detail: i) the sectors in which Russia has potential to reduce energy consumption, ii) the investment required to achieve that potential, and iii) the amount of that investment estimated to be economically and financially viable. Section 4.1 briefly introduces how these potential reductions are estimated.[48] Sections 4.1 through 4.6 show detailed estimates of potential reductions in energy consumption by each major energy consuming sector.

4.1 How to estimate potential energy savings?

Russia's **technically viable potential** for energy savings can be estimated by comparing, for a given sector, the energy efficiency of technologies used in Russia to the energy efficiency of commercially available technologies, used elsewhere in the world. Russia's technical potential is therefore determined by technologies currently in commercial use elsewhere in the world, and not some theoretical minimum level of energy efficiency.

Of these technically viable energy efficiency investments, some save energy, but are too expensive, or yield too little energy savings over their lifetime to be attractive to energy consumers. Financially viable investments are those that save energy and money for the individual consumers – private companies, households, or government agencies – that make the investments. Economically viable investments are those that save energy and money for Russia as a whole over the lifetime of the investment, but the savings cannot necessarily be captured by any single energy consumer. The government may be willing to make such investments in the public's interest, but individual energy consumers will not.

[48] Appendix B contains additional detail on the methodology described in Section 4.1.

More specifically, an investment is **financially viable** if the cost of saving a unit of energy (for example 1 kWh) is less than the cost of buying an additional unit of energy. The cost of saving a unit of energy depends on what upfront capital expenditure must be made, what additional operating and maintenance expenses may be required to save that energy, and what the investor sacrifices by investing in energy efficiency rather than some alternative investment (the investor's opportunity cost of capital). This study assumes a 12 percent opportunity cost of capital for private firms, and a 50 percent opportunity cost of capital for household (individual) investors.[49] The cost of buying an additional unit of energy is determined by the tariff or market price for energy (depending on whether the energy price is regulated) those investors face. This chapter uses as its reference domestic tariffs and market prices for energy in 2007.

An investment is **economically viable** if the cost of saving a unit of energy (for example, saving 1 kWh) is less than the cost to Russia of building a new unit of production capacity (for example, 1 kW), or the opportunity cost to Russia of exporting a unit of gas, whichever is the greater. In determining economic viability, this study calculates the cost of saved energy assuming a 6 percent opportunity cost of capital for the government investing on behalf of the public. This is based on the assumption that government actors require a lower return on investment than private investors but also can attract capital at lower cost. Economically viable investments are also distinguished from financially viable investments in that externalities (positive and negative) are included as part of additional costs. The largest externality considered in the sections that follow is the reduction in carbon dioxide (CO_2) which accompanies many energy efficiency investments. This study assumes that the energy savings achieved in some sectors could be sold as CO_2 reduction credits. The value of these credits is included as an offset to the cost of saved energy, assuming a sale price of €10 per ton of CO_2.[50] The actual economically viable potential of any investment is likely to be much higher since other positive externalities such as the reduction of NOx and other pollution reduction, is difficult to quantify, and therefore not included in this analysis.

This study therefore takes a relatively conservative approach when estimating Russia's potential for improving energy efficiency. The investments found here to be economically unviable, could in fact be viable if externalities are properly quantified, if energy prices increase, or if capital investment costs decrease.

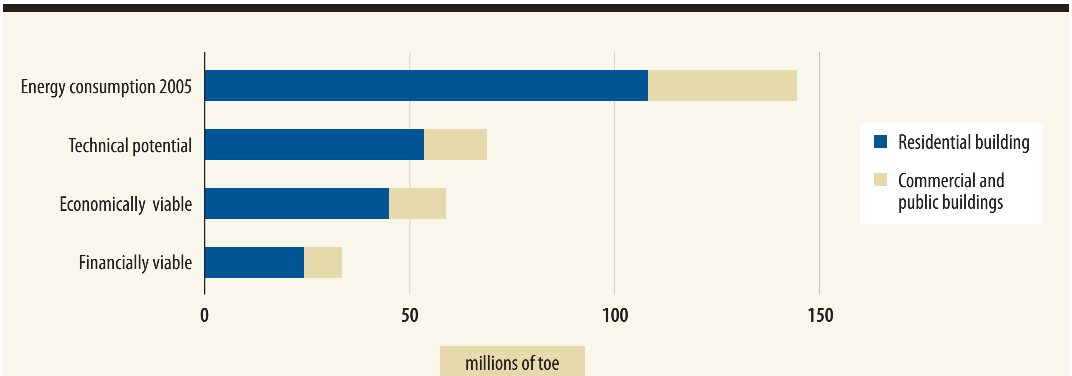
4.2 By how much can Russia improve the energy efficiency of its buildings?

The greatest potential to improve efficiency of final energy consumption lies in Russia's residential, commercial, and public buildings, where energy efficiency investments could save up to 68.6 mtoe per year. Energy use in buildings (144.5 mtoe) was directly responsible for more than one-third of energy end-use in Russia. Two-thirds of the potential energy savings in this sector can be achieved through the reduction of district heating use for space heating and hot water. Figure 20 shows the technically viable, economically viable, and financially viable potential for energy savings in Russia's buildings.

[49] Households will typically have a higher opportunity cost of capital than other private investors because they tend to be more risk averse to making energy efficiency investments, need to borrow at (generally higher) retail lending rates in order to make any significant capital investment, and often have what they perceive to be higher value uses for their free cash.

[50] This study used $13.66 as the price of CO_2 per ton in summer 2007. By the time of publication (Summer 2008), the US dollar price was considerably higher given the depreciation of the US dollar.

Figure 20: Potential for energy savings in Russia's buildings



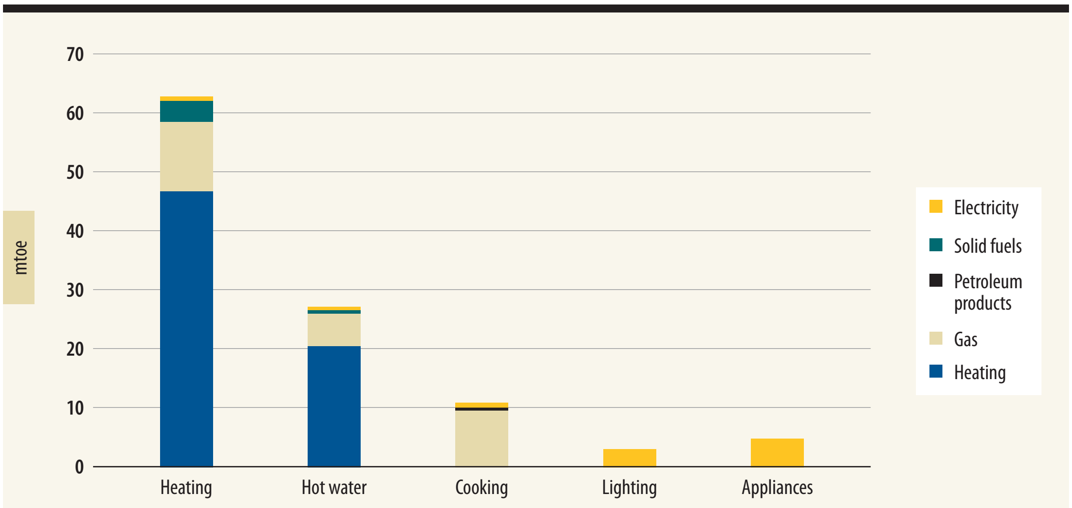
Source: CENEf for the World Bank.

Most of the potential energy savings in buildings can be achieved through investments that are economically and financially viable. Roughly 85 percent of the technical potential can be achieved through investments that are economically viable. Nearly half (45 percent) of the technical potential can be achieved through investments that are financially viable with 2007 energy prices.

Residential buildings

The residential sector is the second largest energy end-user in Russia after manufacturing. No direct statistical data are available on the structure of residential energy consumption by end-use. Russia's CENEf has estimated for the World Bank Group a structure, based on equipment saturation data, shares of dwelling with certain energy using equipment, and SECs for such equipment, which is shown in Figure 21.[51] Space heating is responsible for 58 percent of overall energy consumption in residential buildings, with district heating systems serving three-quarters of dwellings. Water heating is responsible for 25 percent of overall energy consumption in residential buildings.

Figure 21: Residential energy consumption in Russia



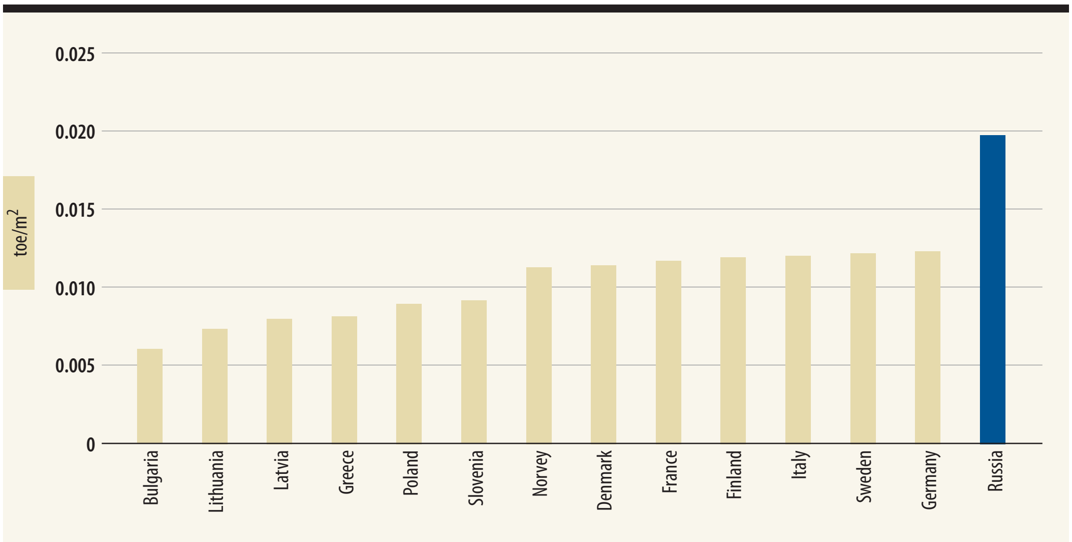
Source: CENEf for the World Bank.

[51] More surveys are needed to improve the statistical knowledge of residential energy end-use structure in Russia.

The residential sector offers the greatest potential for improving energy efficiency in Russia. The technical potential to reduce energy consumption is 53.4 mtoe. Of this technical potential, over 80 percent is achievable through investments that are economically viable and 46 percent is achievable through investments that are financially viable with current domestic fuel prices. Most of the potential energy savings come from improvements in space heating and water heating.

The average space and water heating intensities in Russian buildings are much higher than what could be achieved. The Russian average heating energy intensity for multi-family, high rise buildings is 229 kWh/m^2/year. The heating energy intensity for new, multi-family high rise buildings in Russia is 77 kWh/m^2/year of heat.[52] Rehabilitating existing housing stock can yield energy intensities of roughly 151 kWh/m^2/year.[53] Figure 22 shows how the energy intensity of residential heating in Russia compares to the energy intensities of residential heating in other countries. A small percentage of the buildings erected after 2000 in compliance with new thermal insulation standards actually meet modern thermal performance and heat efficiency requirements. However, the majority of existing buildings have much lower parameters of space heating efficiency. As with space heating, energy intensity of water heating differs depending on the age of the building. Figure 23 shows the estimates of the distribution of hot water energy intensities by age of the building.

Figure 22: Comparative Energy Intensities of Residential Heating, 2004

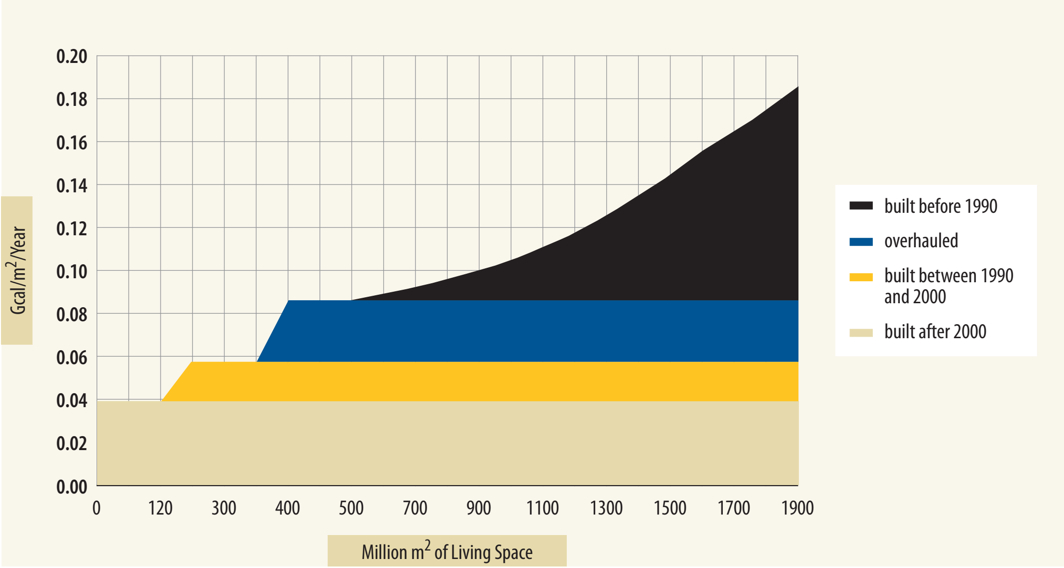


Source: ODYSSEE for all countries except Russia. Russian data from CENEf and Rosstat, "Residential Sector and Consumer Services to Population in Russia", 2007.

[52] This estimate is based on a review of the designs of 28 multi-family, high-rise buildings currently under construction in Moscow.

[53] This estimate is based on similar intensities of renovated high rise buildings in Russia.

Figure 23: Distribution of Residential Buildings with Access to District Heating by Hot Water Energy Intensities



Source: CENEf for the World Bank.

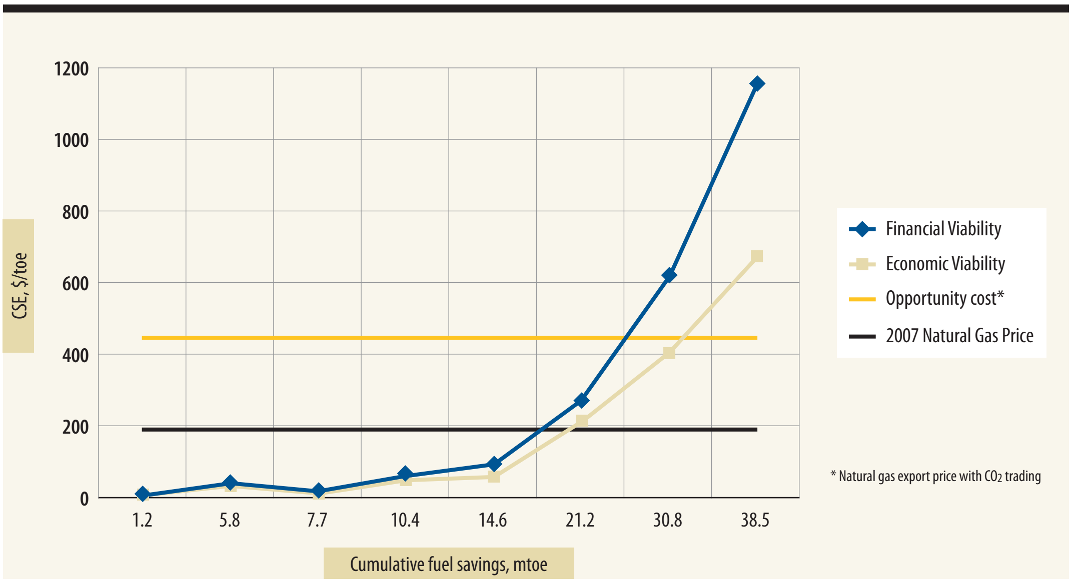
There are significant opportunities for energy savings in both space and water heating in Russia's residential buildings. The technical potential to reduce energy consumption in residential space heating ranges from 17 to 42 mtoe, depending on the method used to estimate the potential.[54] This range of energy savings is equivalent to 35 to 49 percent of total 2005 final heat consumption. Rehabilitating existing housing can save as much as 30-60 percent of 2005 energy consumption for heating. The technical potential for improving the efficiency of water heating is 13.4 mtoe, equivalent to 35 percent of 2005 use. Roughly 12 percent of this improvement comes from rehabilitation of hot water delivery systems through, for example, investments that improve regulation of water temperature and insulation of hot water pipes. Of the potential savings, 38 percent comes from investments within individual apartments, such as installing hot water meters.[55] Installation of hot water meters alone can save as much as 30 to 40 percent energy on hot water by encouraging changes in consumer behavior.

Most of the investments required to improve space and water heating efficiency are economically and financially viable. Figure 24 shows a conservation supply curve for space heating and water heating. Roughly 78 percent of the investments are economically viable. About 38% percent of the technically feasible investments are financially viable with 2007 heat prices.

54 A technical potential of 42 mtoe could be achieved by improving the energy efficiency of all buildings. However, it is more practical to consider the technical potential in the rehabilitation of the existing housing stock rather than overnight replacement of buildings with new, efficient ones. As such, if only buildings built before 1990 were renovated, the technical potential is 17 mtoe. The technical potential increases with the renovation of buildings built after 1990 and reaches 42 mtoe if all buildings were to achieve the technical potential of new buildings that incorporate energy efficiency standards into construction.

55 V. Papushkin, T. Tasenko, I. Bashmakov and others. *Reliable, Energy Efficient Municipal Utility Services.* UNDP, M. 2005.

Figure 24: Conservation supply curve for Space Heating and Water Heating in Residential Buildings



Source: CENEf for the World Bank.

The costs of energy efficiency investments depend on whether the investments are made in existing or new buildings. No incremental investment costs appear to be required for energy efficiency improvements in new buildings in Russia. Other factors, such as the number of floors, building geometry and orientation, cost of materials, and labor costs drive the difference in construction costs.[56] For existing buildings, a number of rehabilitation measures are possible. Figure 25 shows the potential for electricity savings in residential buildings. Table 4.1 shows the energy savings potential of various energy efficiency investments in existing apartment buildings.

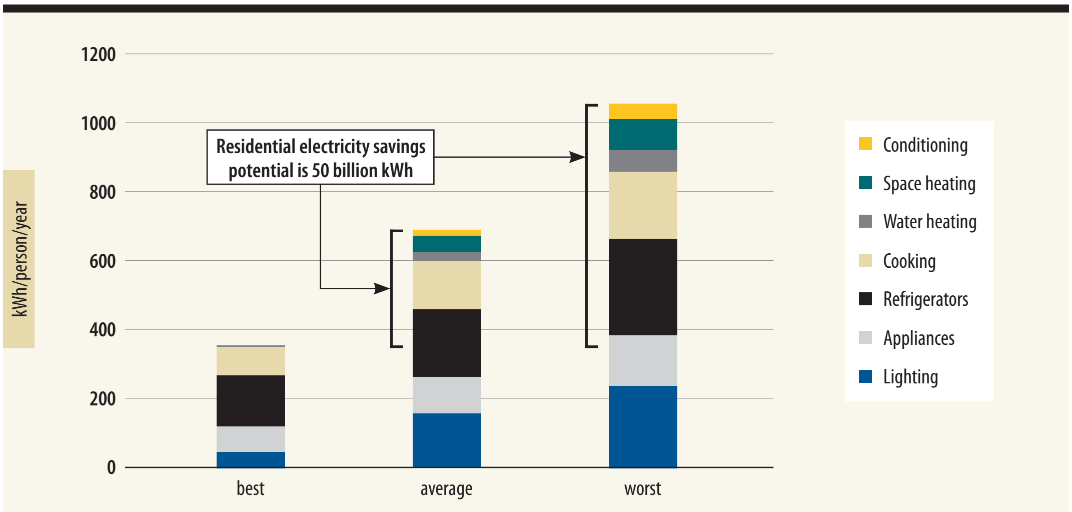
Table 4.1: Space and Water Heating Potential in Residential Buildings

Measures	Technical potential		Total incremental costs	CSE (discount rate=6%)	CSE (discount rate=12%)
	Million Gcal	%	$ million	$/toe	$/toe
Wall insulation (ventilated facade technology)	115.4	30	5239	681.1	1163.9
Efficient faucets	65.4	17	1417	216.7	276.5
Efficient windows	50.0	13	3929	408.7	627.6
Others	50.0	13	268	63.2	97.1
Window heat reflecting films	46.2	12	174	37.7	49.2
Doors weather stripping	26.9	7	145	53.8	64.4
Insulation of indoor DHW pipes	19.2	5	32	16.8	21.9
Radiator heat mirrors	11.5	3	8	7.3	9.4
Total	**384.5**	**100**	**11212**		

Source: CENEf for the World Bank.

56 Based on the lack of observed correlation between cost of construction and energy intensity of heating required in 28 new buildings.

Figure 25: Electricity savings potential in residential buildings

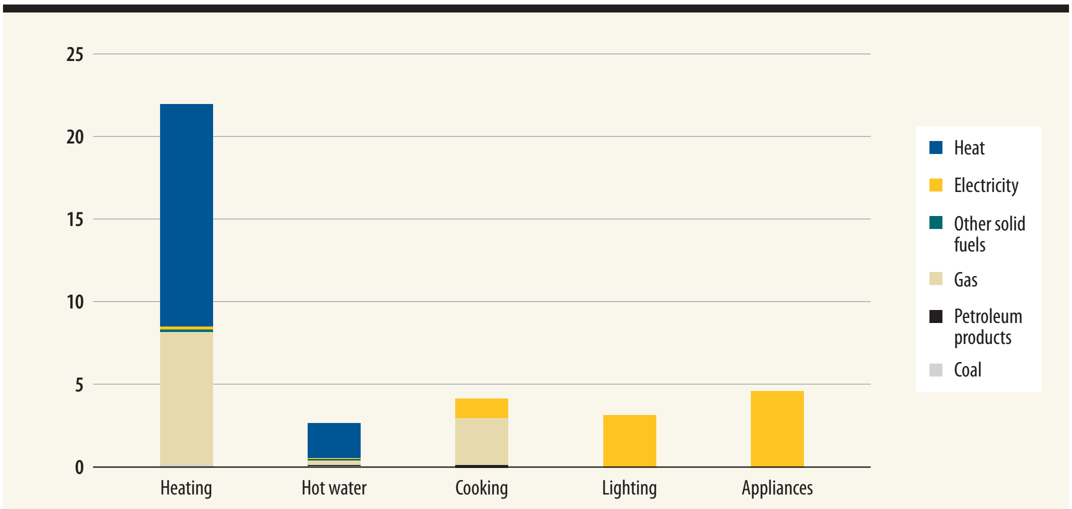


Source: CENEf for the World Bank.

Public buildings

The public sector in Russia is a key final energy user. It is responsible for roughly 9 percent of all energy end-use consumption in Russia. As in the residential building sector, there are no official data on the structure of end-use. Figure 26 shows the structure of public sector consumption as estimated by CENEf for this study. Space heating is responsible for most of the energy use in this sector (roughly 60 percent).

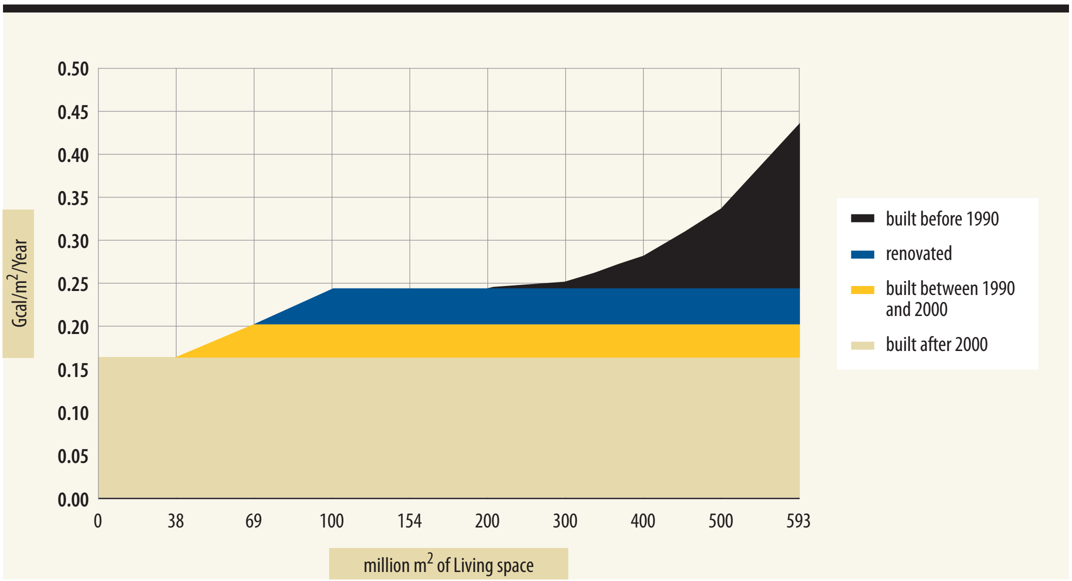
Figure 26: Energy end-use in the public sector, 2005 (mtoe)



Source: CENEf for the World Bank.

There is considerable technical potential for energy savings in Russia's public and commercial buildings. The technical potential for space heating in public buildings is, on average, 49 percent of total consumption by that sector in 2005. This potential has been estimated based on the best energy efficiency of the best new Russian public buildings. However, lack of sufficient data on total floor space of public buildings and lack of data distribution based on building age does not allow for a complete assessment of technical potential, which may be much higher than this study estimates. Figure 27 shows the estimates of the distribution for specific heat consumption by age of the building.

Figure 27: Distribution of public buildings by specific heat consumption for space heating



Source: CENEf for the World Bank.

Technical potential for health care facilities is 60 percent and experience from many Russian regions shows that technical potential for educational institutions is 80 percent. Lighting systems in many Russian schools have not been replaced in 40-50 years and widespread under- and over-heating create vast inefficiencies. In one Moscow school, lighting accounted for 74 percent of overall electricity consumption, yet still did not meet optimal illumination requirements to ensure proper vision health for students and teachers.

The technical potential for gas savings in this sector is equal to 22 percent of 2005 consumption. The technical potential of electricity savings in public buildings is equal to roughly 48 percent of 2005 consumption. Electricity savings for public buildings is particularly noteworthy because of the characteristics of public building electricity consumption. Public facilities contribute two-three times more to peak load consumption and capacity deficits compared to their share of total electricity consumption. As such, the primary energy supply potential for energy savings in public buildings is even greater because less efficient generation is typically used to serve loads during peak periods.

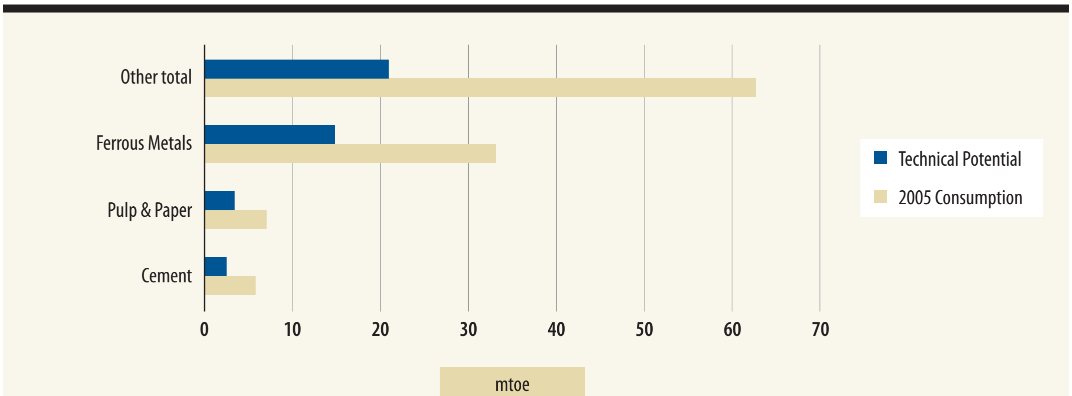
Much of the technical potential for savings in this sector is also economically and financially viable. All of the technical potential for gas savings in this sector is economically viable. Roughly three-quarters of the total technical potential for electricity savings is achievable through investments that are financially viable. One-third of the technical potential for improving energy efficiency in space heating for public buildings can be achieved through investments that are both financially and economically viable. $3-5 billion of the public utility services budget could be saved as a result of investments in energy and water efficiency in public buildings. Investments in federal buildings alone could save at least $1.2 billion per year.[57]

4.3 By how much can Russia improve energy efficiency of Manufacturing?

Russia can cut its total final energy consumption by roughly 5 percent through investments in energy efficiency in manufacturing. With total consumption of 109.5 mtoe, manufacturing is the largest energy end-user in Russia, representing roughly 25 percent of total final energy consumption and 15 percent of total final energy supply. The energy efficiency potential of Russia's manufacturing sector is estimated at 41.5 mtoe per year.

Energy efficiency potential in manufacturing is concentrated in some activities, and widely distributed in others. On the one hand, the three most energy intensive industries – the ferrous metals, pulp and paper, and cement industries – represent 53 percent of energy saving potential, with 39 percent concentrated in ferrous metals, as demonstrated in Figure 28. On the other hand, non-energy intensive industries such as bakeries, meat processing and other represent 42 percent of the potential, and cannot be discounted by policy interventions. Most of the savings can be achieved by improving the efficiency of electricity and heat use at Russia's manufacturing facilities.[58]

Figure 28: Energy Efficiency Potential in Manufacturing



Source: CENEf for the World Bank.

Most of the investments required to improve energy efficiency in manufacturing are economically and financially viable: 97 percent of the technical potential is achievable through investments that are economically viable, while 80 percent of the technical potential is achievable through investments that are financially viable with 2007 gas prices.

57 Based on 2006 prices.

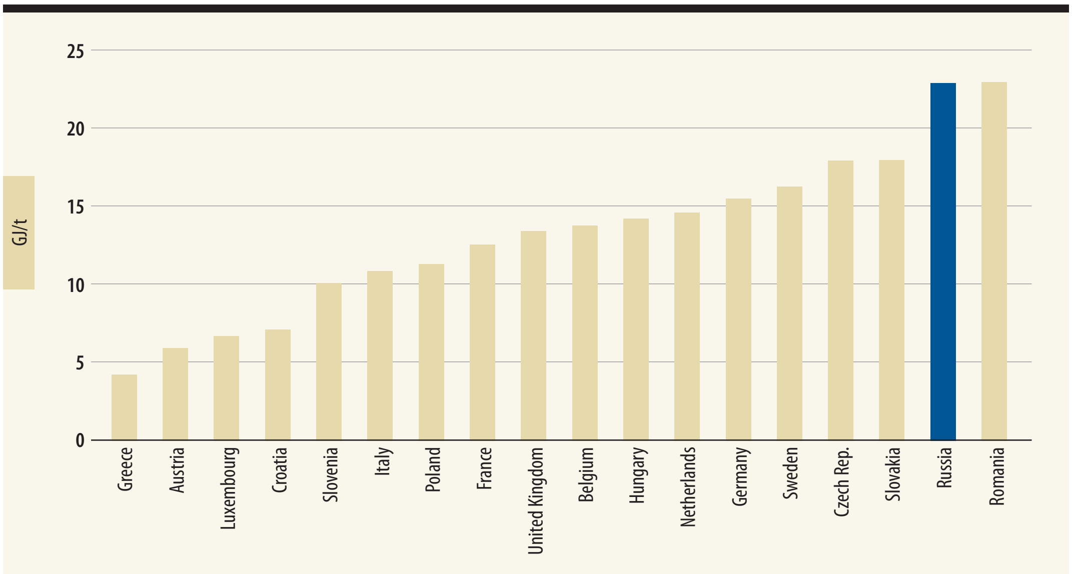
58 Industrial co-generation plants and boiler-houses are included in the assessment of energy efficiency potential in Section 1.4. The estimates of energy efficiency potential in manufacturing therefore exclude savings possible from industrial electricity and heat generation, CHPs, transmission and distribution, energy resources extraction, enrichment or refining.

Russia can more cost effectively invest in energy efficiency than in new energy supply facilities. On average, it costs Russia $294 to achieve 1 toe of energy efficiency savings in manufacturing. In contrast, official estimates for 2010-2020 show that $1,990 to $2,740 are required to increase primary energy production by 1 toe.[59] In the manufacturing sector, Russia can meet rising energy demand at a much lower cost by investing in energy efficiency.

4.3.1 Ferrous metals

Russia's ferrous metals sector consumed 36.1 mtoe in 2005. The energy efficiency of Russian ferrous metal production is well below levels achieved by other major international producers. Figure 29 shows how the energy intensity of Russia's steel industry compares to the energy intensities of European producers.[60] Table 4.2 compares the actual efficiency of Russian plants for different processes to the efficiency of producers abroad.

Figure 29: Comparative Energy Intensity of Steel Production (2005)



Source: ODYSSEE for all countries except Russia. Russian data from CENEf.

Russia can save as much as 16.4 mtoe through energy efficiency investments in the ferrous metals sector – equal to 44 percent of the sector's energy consumption in 2005. 99 percent of total technical potential in the sector can be achieved through economically viable investments (16.3 mtoe). Twelve mtoe can be saved through investments which are financially viable with 2007 gas prices. Table 4.2 shows those investments with the greatest technical potential to save energy.

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59 Russia's long-term economic development projections for 2007-2030 (scenarios). Russian Academy of Science, Institute for economic projections. Moscow, May 2007.

60 Energy intensity data for Russia are for 2005. EU data are for 2004, but relative energy intensities are not likely to have changed dramatically between 2004 and 2005.

Table 4.2: Actual Efficiency and Benchmarks for Ferrous Metal Production

Process	Average Russian Energy Intensity (GJ/t)	International Comparator[61] (GJ/t)	Investments/Improvements
Ore production and enrichment	0.34	0.289	
Sintering	1.83	1.49	Improving plant heat recovery, reduction of compressed air leaks, improved process control, and the use of waste fuels in sinter plants
Pellet production	1.28	0.7	Same as for sintering
Coke production (excluding Coke batteries heating)	1.39	0.92	Pulverized coal injection technologies in blast furnaces
Pig iron production	16.9	11.2	Top pressure recovery turbines, blast furnace gas recovery, hot blast furnace automation, and improved blast furnace controls
Electric arc furnaces	3.2	1.6	Scrap preheating and increase oxygen use[62]
Open hearth furnaces	5	0.38	Switching to oxygen furnace.
Rolled steel production	4.01	0.4 for cold rolled steel; 0.9-1.6 for hot rolled steel	Transition to continuous, near-net shape and thin strips casting, which eliminates slabs heating and cooling stages and reduces rolling cycles

Source: CENEf for the World Bank.

Most of the savings comes from the use of pulverized coal injection technologies in blast furnaces which allow for the replacement of coke with coal and thus avoid the need for coke making. Other energy saving technologies, ranked by their relative costs include: electric arc furnace upgrade; improved blast furnace control systems; process control in hot strip mill; recuperative burners; programmed heating; automated monitoring and targeting system; efficient ladle preheating; heat recovery on the annealing line; blast furnace gas recovery; reduced steam use in cold rolling; pulverized coal injection; controlling oxygen levels and variable speed drives; hot blast furnace automation; energy efficient drives for hot rolling; sintering and pellets production improvements; iron ore production and enrichment improvements; waste heat recovery (cooling water); hot charging; insulation of furnaces for hot rolling; thin strip and near-net-shape casting; continuous casting; dry quenching; top pressure recovery systems; and coal moisture control.[63]

61 E. Worrell, M. Neelis, L. Price, et al. World best practice energy intensity values for selected industrial sectors.. LBNL-62808. June 2007.

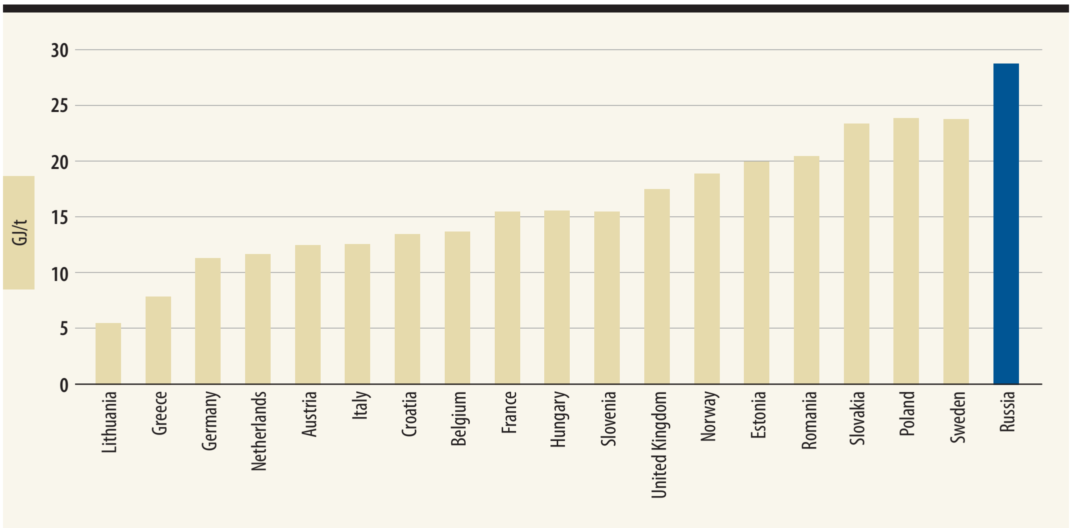
62 See "Using energy and materials more efficiently: a precondition for sustainable development". Conference organized by Korea Resource Economics Association (KREA), Korea Energy Economics Institute (KEEI), Centre for Energy Policy and Economics (CEPE), ETH Zurich, Switzerland and Ecofys, Utrecht, the Netherlands. Seoul, Republic of Korea. September 21-22, 2006, and *Energy Technology Perspectives 2006. Scenarios and Strategies to 2050.* OECD/IEA. 2006.

63 Cost and savings data for each technology or group of technologies were taken from several sources, and figures for earlier years were adjusted for dollar inflation. Sources used were: Energy Technology Perspectives 2006. Scenarios and Strategies to 2050. OECD/IEA. 2006; "Using energy and materials more efficiently: a precondition for sustainable development." Conference organized by Korea Resource Economics Association (KREA), Korea Energy Economics Institute (KEEI), Centre for Energy Policy and Economics (CEPE), ETH Zurich, Switzerland and Ecofys, Utrecht, the Netherlands. Seoul, Republic of Korea. September 21-22, 2006; Ernst Worrell, Natan Martin, and Lynn Price. "Energy Efficiency and Carbon Dioxide Emissions Reductions Opportunities in the U.S. Iron and Steel Sector." Ernest Orlando Lawrence Berkeley National Laboratory, University of California. July, 1999; "Energy and environmental profile of the U.S. iron and steel industry." Prepared by: Energetics, Inc. Columbia, Maryland, for U.S. Department of Energy, Office of Industrial Technologies. July 1996.

4.3.2 Pulp and paper

Russian pulp and paper mills could cut their energy use by roughly 50 percent. In 2005, energy use in pulp and paper production totaled 6.9 mtoe. The technical potential for energy efficiency improvements in pulp and paper making is 3.7 mtoe. The average energy intensity of Russian pulp production is 18.1 GJ/t of pulp. International energy intensity of pulp production ranges from 11-14.3 GJ/t of pulp.[64] The most energy intensive process in paper making is paper drying, which is responsible for 25 to 30 percent of overall energy consumption in pulp and paper making combined. All but one Russian paper producing plants have energy intensities far above their peers abroad, leaving a large potential for improvement.[65] Figure 30 shows how the energy intensity of Russia's paper industry compares to the energy intensities of paper production in European countries.[66]

Figure 30: Comparative Energy Intensities of Paper Production (2005)



Source: ODYSSEE for all countries except Russia. Russian data from CENEf.

Most of the technical energy efficiency potential is achievable through investments that are economically and financially viable. Technologies that would improve the energy efficiency of pulp making include (in order of lowest CSE): batch digester modifications, continuous digesters, and heat recovery in thermo-mechanical pulping.[67] Advanced technologies to reduce energy intensity of pulp production also include the gasification of black liquor and other biomass residuals from pulp production. Technologies that would improve the energy efficiency of paper making include (in order of lowest CSE): infrared profiling; extent nip press; high consistency forming; gap forming; and dry sheet forming.[68]

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64 Energy Technology Perspectives 2006 and Proceedings; E. Worrell, M. Neelis, L. Price, et al. "World best practice energy intensity values for selected industrial sectors." LBNL-62808. June 2007; 1998 Seoul Conference on Energy Use in Manufacturing: Energy Savings and CO_2 Mitigation Policy Analysis.

65 The energy intensity of paper production varies considerably depending on the quality of the paper being produces. This study takes as its point of comparison the production of uncoated, fine paper.

66 Energy intensity data for Russia are for 2005. EU data are for 2004, but relative energy intensities are not likely to have changed dramatically between 2004 and 2005.

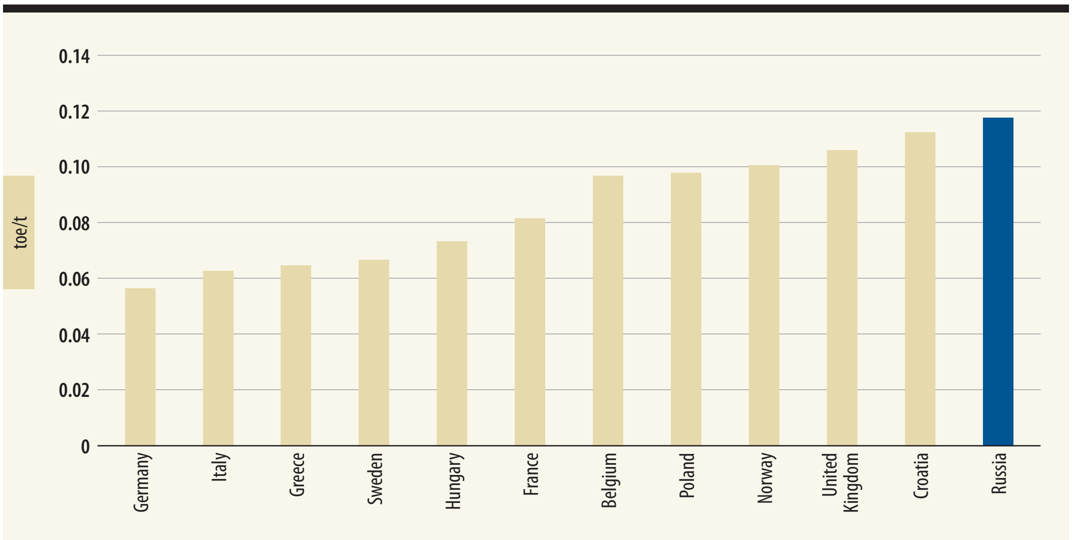
67 N. Martin, N. Angliani, D. Einstein, M. Khrushch, E. Worrell, L. Price. "Opportunities To Improve Energy Efficiency in The U.S. Pulp And Paper Industry, 2001." Proceedings Paper Machine Technology, February 7-8, 2001, Lanaken, Belgium. LBNL. 2001.

68 Ibid.

4.3.3 Cement production

Russia's cement industry could cut its energy use by 43 percent. Russian cement and clinker producers consumed 5.7 mtoe in 2005. Technical potential in the cement industry is 2.5 mtoe, of which two-thirds of the potential lies in improving the energy efficiency of clinker production. Average energy intensity of Russia's cement and clinker producers was 4.9 GJ/t in 2005. This level of energy intensity is considerably higher than most energy efficient cement and clinker producers abroad. Figure 31 shows how the energy intensity of Russian cement producers compares to producers in Europe. As another example, Russia's energy intensity was 76 percent higher than energy intensity of cement and clinker production in South Korea[69]. In cement production, the best international energy intensities range from 0.09-0.11 GJ/t. Energy intensities observed at Russian cement facilities never falls below 0.2 GJ/t. In clinker production, using dry kilns, international energy intensities are as low as 3 GJ/t. Wet kilns are less efficient, with energy intensities ranging from 5.5-7 GJ/t. The average energy intensity of clinker production in Russia is 8.8 GJ/t.

Figure 31: Comparative Energy Intensities of Cement Production (2004)



Source: ODYSSEE for all countries except Russia. Russian data from CENEf.

All of the technical potential for energy efficiency improvement in cement and clinker production is economically viable, and most of it is financially viable. Most of the energy efficiency potential in clinker production can be achieved by moving more production to dry kilns. Dry kilns were used at roughly 15 percent of Russian clinker production, versus 100 percent in Japan, 93 percent in South Korea and India, 65 percent in the US and 58 percent in Western Europe.[70]

Most of the savings achieved in the cement and clinker industry are through gas savings. Russian cement and clinker producers use natural gas as their principal fuel. In Russia, natural gas constitutes 90 percent of fuel consumed by cement and clinker producers, while in Europe and North America coal constitutes 80 to 95 percent of fuel consumption.

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69 Using energy and materials more efficiently: a precondition for sustainable development. Conference organized by Korea Resource Economics Association (KREA), Korea Energy Economics Institute (KEEI), Centre for Energy Policy and Economics (CEPE), ETH Zurich, Switzerland and Ecofys, Utrecht, the Netherlands. Seoul, Republic of Korea. September 21-22, 2006.

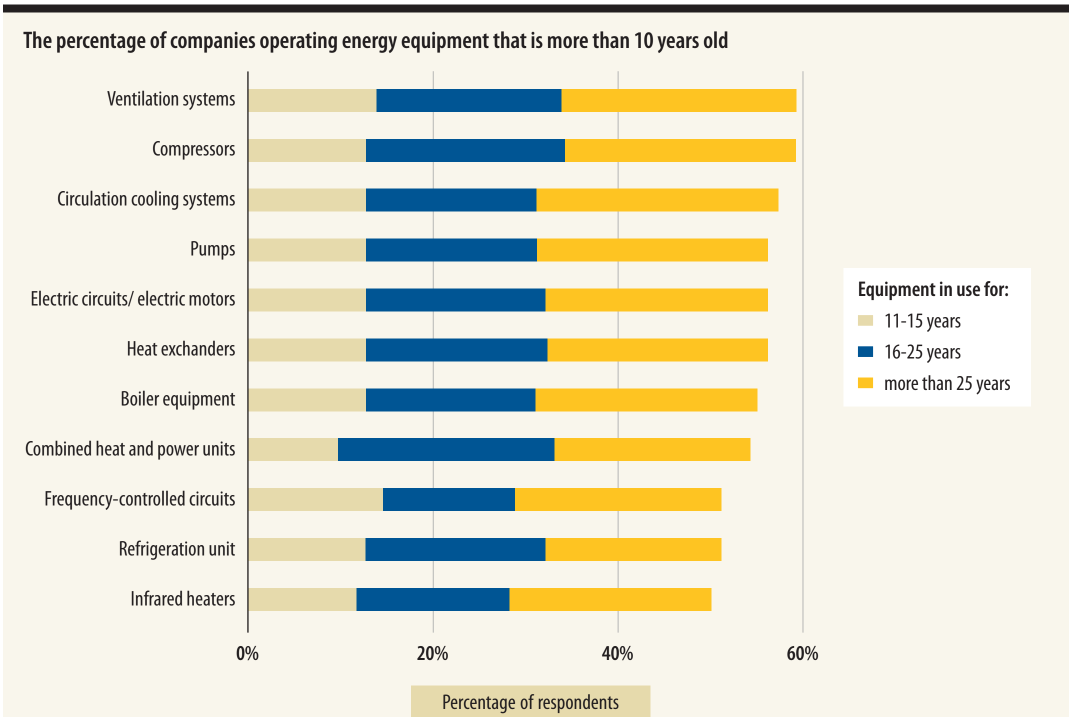
70 *Energy Technology Perspectives* 2006.

4.3.4 Non-energy intensive industries

Non-energy intensive industries represent 42 percent of energy efficiency potential in manufacturing and account for 20 percent of all electricity saving potential in final consumption. In 2005 non-energy intensive industries consumed 53 mtoe. They have the potential to reduce their energy consumption by 32 percent.

The underlying reason for existing inefficiencies in non-energy intensive industries is outdated equipment and management practices. As presented in Figure 32 more than a quarter of companies use equipment for more than 25 years.

Figure 32: Obsolete equipment in non-energy intensive sectors



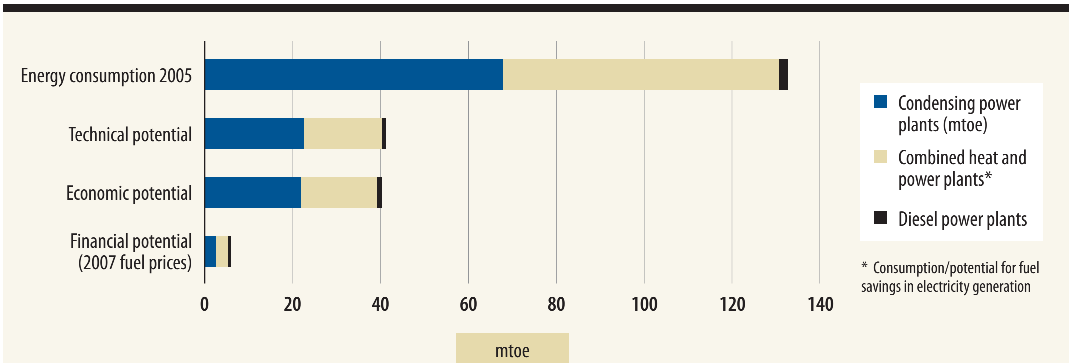
Source: IFC *On the road to energy efficiency: experience and future outlook.*

Existing practices among Russian mid-sized companies in improving energy efficiency indicate that almost half of energy efficiency improvements are being made in production line improvements while the rest are being made in generic energy equipment.

4.4 By how much can Russia improve the energy efficiency of electricity generation and delivery?

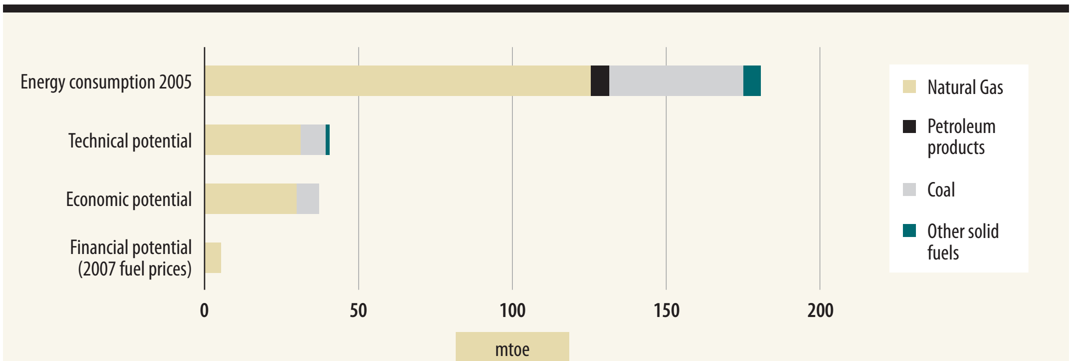
Russia could reduce the fuel consumed in its electricity plants by nearly 31 percent. However, this is a conservative estimate as it does not include the energy savings that can be realized in the sector as a result of higher utilization of CHPs, distributed generation, and optimization of energy delivery system designs. Figure 33 shows the technically viable, economically viable, and financially viable potential for Russia to improve energy efficiency in electricity generation. Figure 34 shows the same information, categorized by fuel type.

Figure 33: Potential to improve energy efficiency in electricity generation, by technology



Source: CENEf for the World Bank.

Figure 34: Potential to improve energy efficiency in electricity generation, by fuel type



Source: CENEf for the World Bank.

Much of this technical potential is economically viable, but not financially viable. Roughly 90 percent of the technical potential is economically viable. Only 13 percent of the technical potential is financially viable with domestic gas prices for 2007.

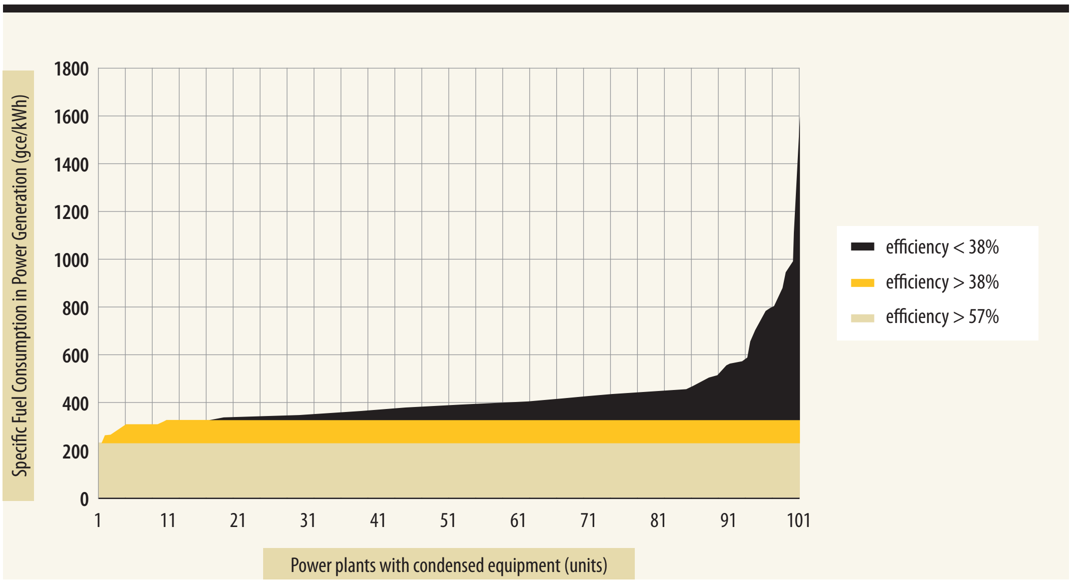
Russia would need to invest $106 billion to improve the efficiency of thermal power plants.[71] Of this total, $49.8 billion would be needed to improve the efficiency of condensation power plants. $55.4 billion would be needed to improve the efficiency of CHPs. Most of the potential can be captured by upgrading gas-fired condensing power plants and combined heat and power plants, and most of the fuel savings is accordingly in gas consumption.

Condensing power plants

The efficiency of Russia's condensing power plants is well below the average efficiency of similar plants elsewhere in the world. Russia's condensing power plants operate, on average, at 36 percent efficiency with 345 gce/kWh average specific fuel consumption. Only two power stations (Sochinskaya TES and Severozapadnaya GRES-2) are reported to operate at levels of efficiency above 40 percent. Five other plants (Permskaya, Sredneuralskaya, Nizhnevartovskaya, Kostromskaya, and Surgutskaya) run at slightly above 38 percent efficiency. The highest level of energy intensity (lowest level of efficiency) for electricity generation is as high as 1.6 gce/kWh. Figure 35 shows the distribution of efficiencies of kWh generated by Russia's condensing power plants.

71 Each plant falling below the international efficiency benchmark was replaced at a level of capacity equivalent to its loaded capacity in 2005.

Figure 35: Distribution of Energy Efficiency at Russian Condensing Power Plants



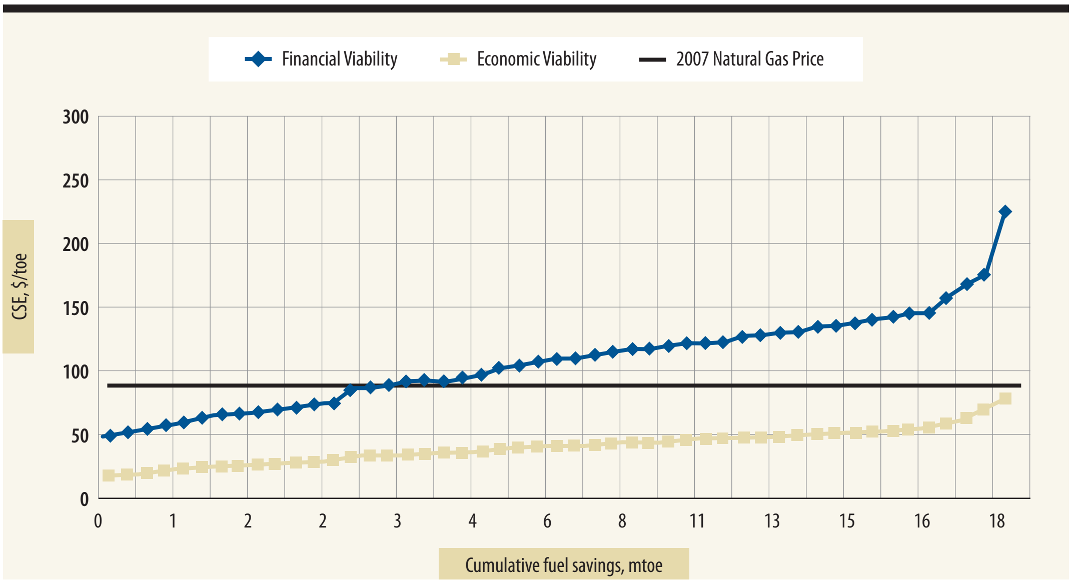
Source: CENEf for the World Bank.

In contrast, coal- and oil-fired condensing power plants in OECD countries operate at an average efficiency of 38 percent, and gas-fired condensing power plants in OECD countries operate at an average of 41 percent efficiency. In some countries, combined-cycle gas plants achieve efficiencies as high as 57 percent, and some coal plants (such as Denmark's Nordjylland coal plant) achieve efficiencies as high as 47 percent.[72]

The technical potential for reducing total final consumption of condensing power plants in Russia is 22.5 mtoe. Of this, 79 percent come from savings in gas consumption. All of the technical potential for improving natural gas-fired condensing power plants (17.9 mtoe) is achievable through investments that are economically viable. Only 13 percent (2.4 mtoe) of that potential is achievable through investments that are financially viable with 2007 gas prices. Figure 36 shows this conclusion graphically. The potential for energy efficiency gains at liquid fuel-fired condensing power plants and coal-fired condensing power plants were much smaller, in part because these plants generate a much smaller proportion of Russia's electricity than gas-fired plants.

[72] *Energy Technology Perspectives 2006. Scenarios and Strategies to 2050.* OECD/IEA. 2006.

Figure 36: Conservation supply curve for Natural Gas-Fired Power Plants in Russia



Source: CENEf for the World Bank.

In estimating the technical potential for efficiency gains, it was assumed that all plants below the best international use would be replaced with the most advanced units of appropriate capacity. It was assumed that only generators serving load in 2005 would be replaced; while idle plants would not be replaced. Replacement capital costs were assumed to be $700/kW for gas-fired power plants; $800/kW for plants fueled by liquid petroleum products; and $1,400/kW for coal-fired plants.[73]

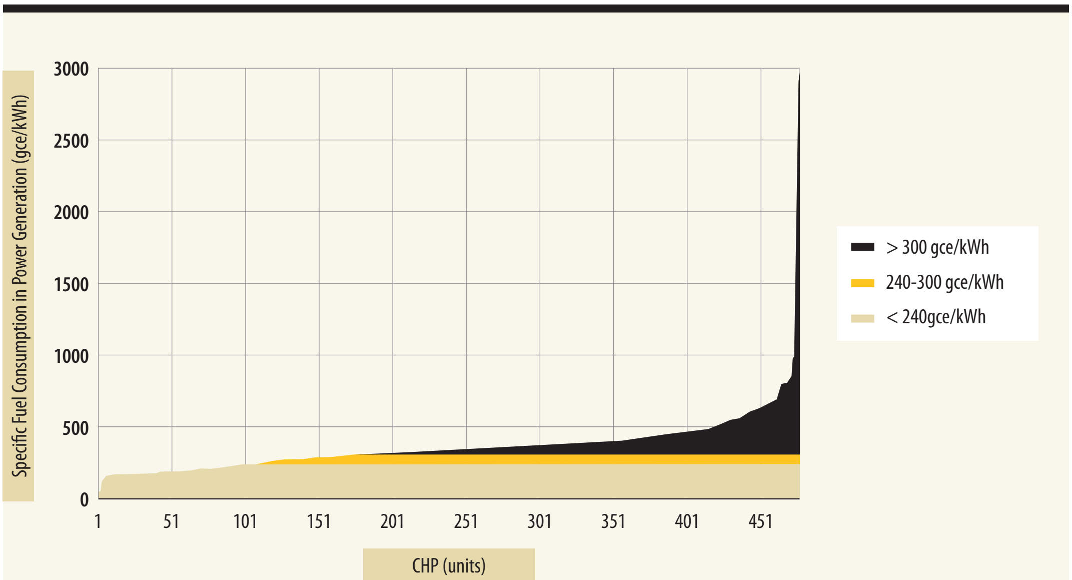
Cogeneration (Combined Heat and Power Plants or CHPs)

Russia's co-generation plants (also called combined heat and power plants, or CHPs) operate at a level of energy efficiency well below that of most technologies used internationally. Gas-fired CHPs abroad typically operate at 51 percent efficiency in condensing mode, and 46-48 percent for liquid- and solid-fuel fired CHPs in condensing mode. Russia's gas-fired CHPs currently operate at 39 percent efficiency in condensing mode. Liquid- and solid-fuel fired CHPs operate at 36 percent efficiency in condensing mode. The efficiency advantages of Russian CHPs over condensing plants are therefore minimal. Figure 37 shows the distribution of Russian CHPs by energy efficiency.

All of the technical potential for gas-fired CHPs (13.7 mtoe) are achievable through investments that are economically viable. At 2007 gas prices, only 3.1 mtoe is achievable through investments that are financial viable. As is the case with condensing power plants, most efficiency gains come from upgrading gas-fired facilities. Upgrading these plants to 51 percent efficiency could bring about a 14 mtoe (17 bcm) reduction in natural gas consumption. Figure 38 shows this relationship graphically.

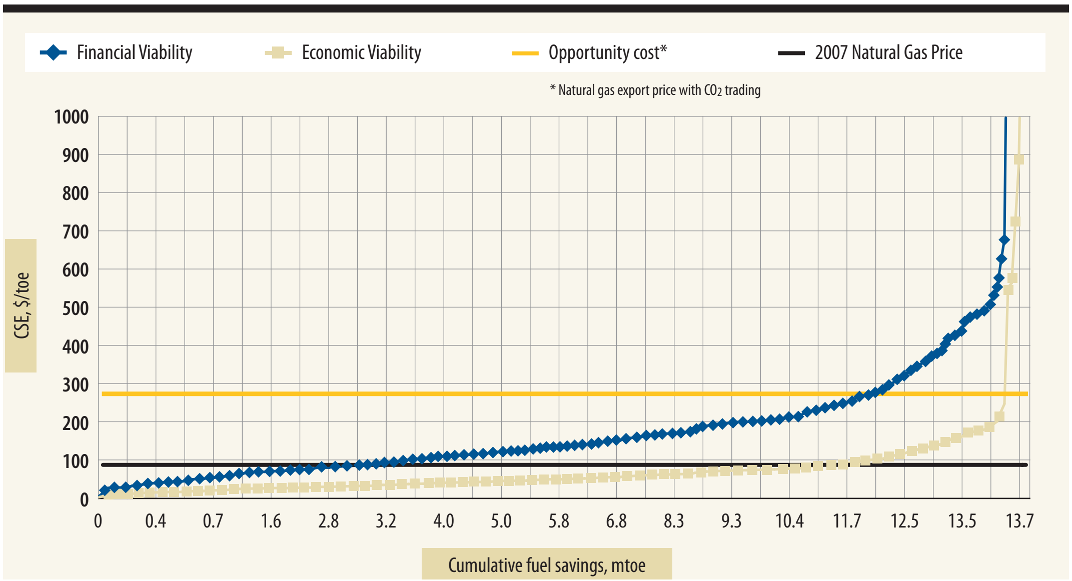
[73] In practice, the costs of new capacity in Russia are likely to be higher as these estimates exclude financing costs, licensing costs, and land acquisition costs.

Figure 37: Distribution of Russian CHPs by Energy Efficiency



Source: CENEf for the World Bank.

Figure 38: Conservation supply curve for Natural Gas-Fired CHPS Plants in Russia



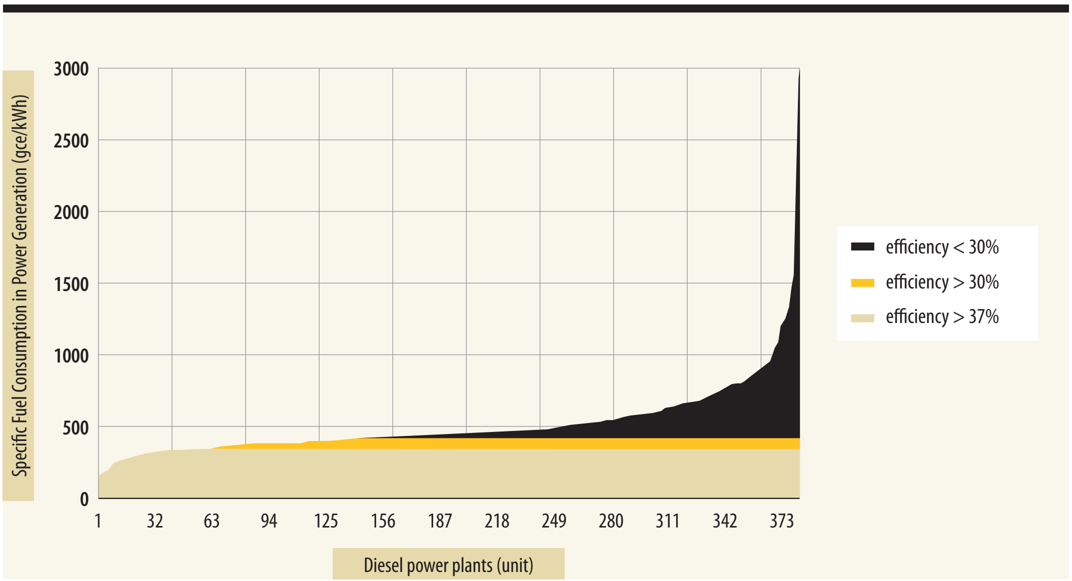
Source: CENEf for the World Bank.

Diesel power plants

Russia's diesel power plants operate far below the efficiency of comparable plants abroad. These plants operate at an average efficiency of 25 percent, with an average fuel consumption of 495 gce/kWh. Efficiency levels of 37 percent are achievable elsewhere in the world.[74] Figure 39 shows the distribution of Russian diesel power plants by energy efficiency.

74 Data are taken from major equipment manufactures' websites.

Figure 39: Distribution of Russia's Diesel Plants by Energy Efficiency



Source: CENEf for the World Bank.

Upgrading Russian diesel power stations to 37 percent average efficiency would bring 0.59 mtoe in savings of both diesel fuel and natural gas.[75] Only 0.47 mtoe of the technical potential is achievable through investments that are economically viable. Only 0.11 mtoe of the technical potential is achievable through investments that are financially viable.

Transmission and distribution

Russia could also save substantial electricity by reducing losses on its electricity transmission and distribution networks. Russia's electricity transmission and distribution losses exceed levels achieved elsewhere. In the OECD countries, distribution losses range from 6 to 7 percent of total power production. In Finland, the total losses are as low as 4 percent. Average electricity distribution losses in Russia were 12.2 percent in 2005. In 2004, distribution losses were 8.4 percent in Moscow, 14 percent in Sakhalinskaya Oblast, 18 percent in Moscow Oblast. In Astrakhanskaya Oblast, losses exceeded 20 percent in 2004. The potential for reducing Russia's electricity distribution losses accounts for 3.4 mtoe, or roughly 35 percent, of actual levels in 2005 (9.69 mtoe).

4.5 By how much can Russia improve the energy efficiencies of its heat supply systems?

Russian heat production and distribution are energy intensive relative to international practice. The potential to improve the energy efficiency of CHPs was discussed in the preceding section. After CHPs, the greatest potential energy savings come from investments to improve the efficiency of heat generation at gas fired industrial boilers, and the efficiency of heat distribution in municipal heating systems. Figure 40 shows the technical, economic and financial potential to improve heat generation and distribution. The use of CHPs can markedly improve overall energy efficiency in the heating sector, but that potential has not been included here.

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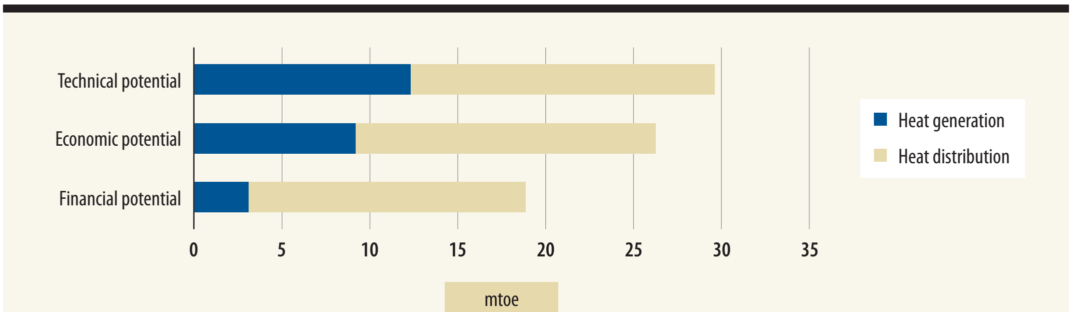
75 Natural gas-fired diesels typically operate in those Russian provinces where gas is produced.

Figure 40: Potential to improve energy efficiency in heat production and distribution



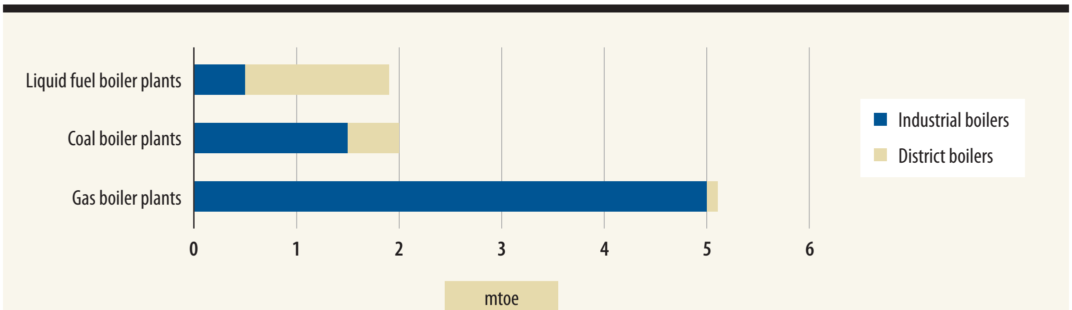
Source: CENEf for the World Bank.

Boilers used to supply heat in Russia could cut their energy consumption by 10.4 mtoe, or 8.4 percent. The investment required to meet this potential would be roughly $7 billion. Roughly 90 percent of the technical potential is achievable through investments that are economically viable. With 2007 domestic natural gas prices, only 25 percent of the technical potential is achievable through investments that are financially viable.

Most of Russia's boilers fall short of the best international energy intensities. This study uses 95 percent efficiency as the international benchmark for gas- and liquid-fuel boilers, and 85 percent efficiency as the international benchmark for coal-fired boilers. These efficiencies are consistent with the efficiency of boilers operating in Western Europe. Official reports on Russian boiler efficiency show the efficiency of CHPs at 95.3 percent, industrial boilers at 68.6 percent; district heating boilers at 80.3 percent, and small boilers at 81.6 percent.[76] Russia's boilers are likely less efficient than official statistics suggest. Energy audits conducted by Russia's Center for Energy Efficiency (CENEf) cast doubt on the accuracy of the official figures.

As Figure 41 shows, gas-fired industrial boilers show the largest potential for improvement. Russia's boilers consumed 123.2 mtoe in 2005, of which industrial boilers consumed 66 percent. Installing gas-fired industrial boilers with the best international technology can bring 5.1 mtoe in natural gas savings, much of which is through investments that are economically and financially viable. Investments yielding 5.1 mtoe are economically viable. Investments yielding only 0.6 mtoe of savings are financially viable with 2007 domestic gas prices.

Figure 41: Technical potential for improving boiler efficiency



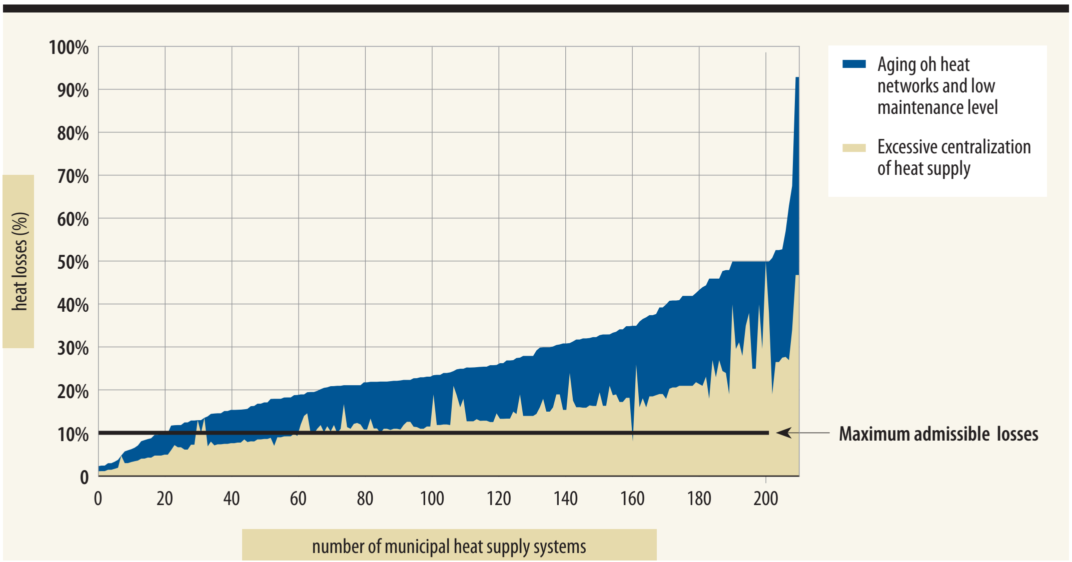
Source: CENEf for the World Bank.

76 Statistics report specific energy consumption to generate a unit of heat. As CENEf's experience in many energy audits shows, in practice small boilers are the least energy efficient. So statistical data do not mirror the real situation.

Municipal heat distribution losses in Russia are also high relative to heating systems in other countries. In Western European countries with well-developed heat supply systems, distribution losses range from 2 to 10 percent of total heat generation. In Helsinki, distribution losses in the district heating network are about 6 percent. Beyond 10 percent, district heating systems become physically less energy efficient than distributed generation. In Russian municipal heating systems, heat distribution losses are estimated at 20-25 percent of total heat generation, but available statistics are very unreliable and typically understate real losses.

Figure 42 shows how the losses are distributed by heat network. The potential for reducing heat losses was estimated at 17.3 mtoe, equivalent to 8.9 percent of total heat production. Of this technical potential, 17.1 mtoe is achievable through investments that are economically viable. Much of the potential is also achievable through investments that are financially viable: 15.9 mtoe with 2007 fuel prices. The capital cost of achieving this potential is estimated at $18.6 billion. The purchase of new pipes also helps reduce supply interruptions and repair costs, and extend heat pipes service life.

Figure 42: Distribution of heat networks by heat distribution losses

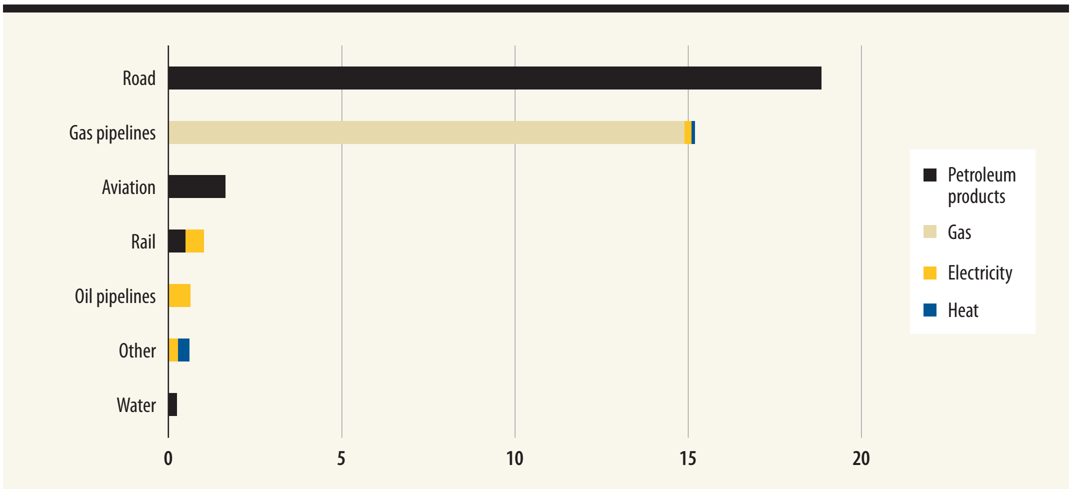


Source: CENEf for the World Bank.

4.6 By how much can Russia improve the energy efficiency of its transport sector?

The Russian transport sector is the fifth largest energy consuming sector after heat and electricity generation, manufacturing, and residential buildings. Russian transportation was responsible for 25 percent of final energy consumption (94.4 mtoe) in 2005. Russia can reduce energy consumption in its transport sector by 38.3 mtoe, an amount equal to 41 percent of the transport sector's consumption in 2005. Figure 43 shows technical potential by transport mode and fuel type. Most of this potential is economically and financially viable (36.2 mtoe and 32 mtoe, respectively).

Figure 43: Potential to improve energy efficiency in transport (mtoe)



Source: CENEf for the World Bank.

Within the transportation sector, road transport is responsible for the largest consumption of energy, followed by gas transport. The road transport sector is responsible for 48 percent of all energy consumption in the transport sector, and has the largest potential for improvement. In passenger transport (personal cars excluded), rail transport dominates, followed by buses and air transport. Their combined potential of these transport modes, however, is responsible for only 9.2 percent of total transport sector potential. Transportation and distribution associated with Russia's large natural gas industry explains why the share of petroleum products in the Russian transport energy mix is just 57 percent versus 97 percent in most OECD countries in 2005[77]. Transportation of energy (coal, crude oil and petroleum products, gas and other fuels) is responsible for 40-45 percent of overall energy consumption by the transportation sector and has as much as 42 percent potential.

Russia's systems of freight transportation are relatively efficient. Relatively limited improvement can be achieved by structural changes in freight transportation. Much of the freight transported is fuel, which is therefore transported by pipeline.[78] As much as 54 percent of freight (in terms of km-tons) is transported by pipelines followed by 42 percent by rail. Transportation by truck constitutes only 0.9 percent. Only water transport, which is one of the most energy efficient and cost effective, stands out as an area for possible improvement. Only 2.3 percent of freight is moved using water transport in Russia.[79]

Road transport

Road transport is a fast-growing energy consumer, driven by dynamic personal fleet growth at the expense of public transport. During 1995-2006, private car ownership grew by 84 percent, and will continue to grow steadily over the coming years as personal car ownership remains far below levels in most developed countries. Unfortunately, data allocating fuel consumption by type of road

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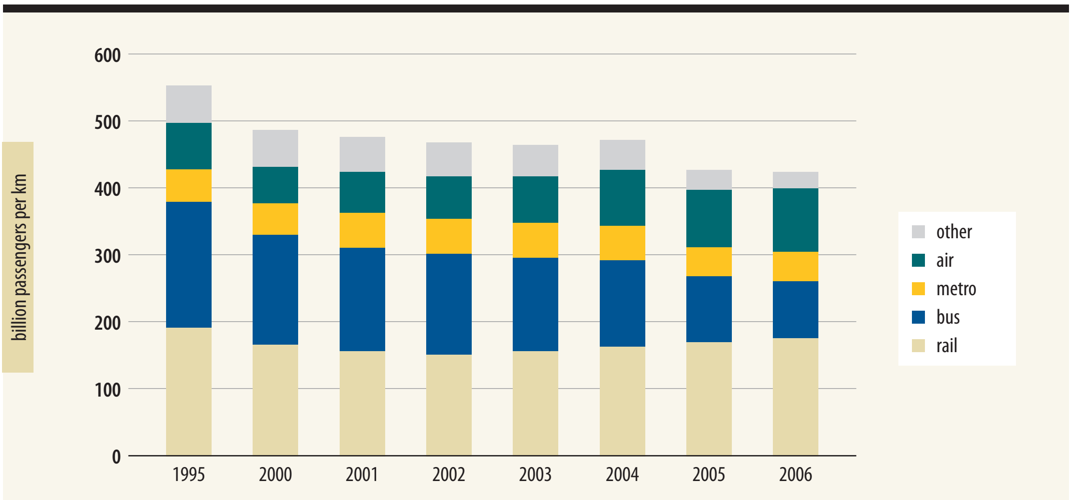
77 *Energy Balances for OECD countries.* 2004-2005. OECD/IEA. 2007 Edition.

78 Transportation of energy (coal, crude oil and petroleum products, gas and other fuels) is responsible for 40-45 percent of overall energy consumption by the transport sector.

79 *Transport in Russia, 2007,* Rosstat.

vehicles is limited, making it difficult to develop a full assessment of energy efficiency potential. The increase in personal car ownership has been accompanied by a 23 percent decline in public transportation during 1995-2006.[80] The use of public transportation by sea and river decreased 10-fold and two-fold, respectively (see Figure 44). Public transportation by buses halved, while the number of large city and inter-city buses in service fell by 43 percent during the same period. In 2005, road transportation consumed roughly 48 mtoe, equal to more than half of all energy consumed by the transport sector. At 9.5 mtoe, diesel fuel accounted for roughly 20 percent of road transport energy consumption.[81]

Figure 44: Change in public transportation usage from 1995 to 2006



Source: *Transport in Russia,* 2007. Rosstat.

Russia could improve the energy efficiency of its petrol-driven light duty vehicles by 17 mtoe, or roughly 18 percent of total 2005 energy consumption in the transport sector. Personal passenger cars in Russia have estimated energy intensities of 10-12 liters/100 km; light trucks have energy intensities of 29-33 liters/100 km; and buses have energy intensities of 41-55 liters/100 km.[82] Russia's KAMAZ trucks typically use 38 liters/100 km, more than twice the fuel efficiency of comparable models manufactured by Western companies like Caterpillar.[83] Moreover, when importing cars, Russians typically choose less efficient, second-hand cars because they are cheaper. In contrast, hybrid electric drive vehicles have energy efficiencies of 5.5 liters/100 km. The IEA reports that energy intensities for advanced gasoline- and diesel-fired vehicles with progressive engine downsizing, efficient combustion, and increased use of variable valve control reaches 5.4-9.7 and 4.2-7.5 l/100 km[84]. Figure 45 shows how Russia compares to European countries in terms of energy intensity of automobile passenger

80 *Transport in Russia, 2007.* Rosstat.

81 In Russia, like elsewhere, there is a shortage of both statistical information and special studies on energy use in transport (especially personal) as well as contradictory information on some indicators, like transport vehicles stock, freight turnover, and average mileage. This less than ideal data leads to estimates that are limited.

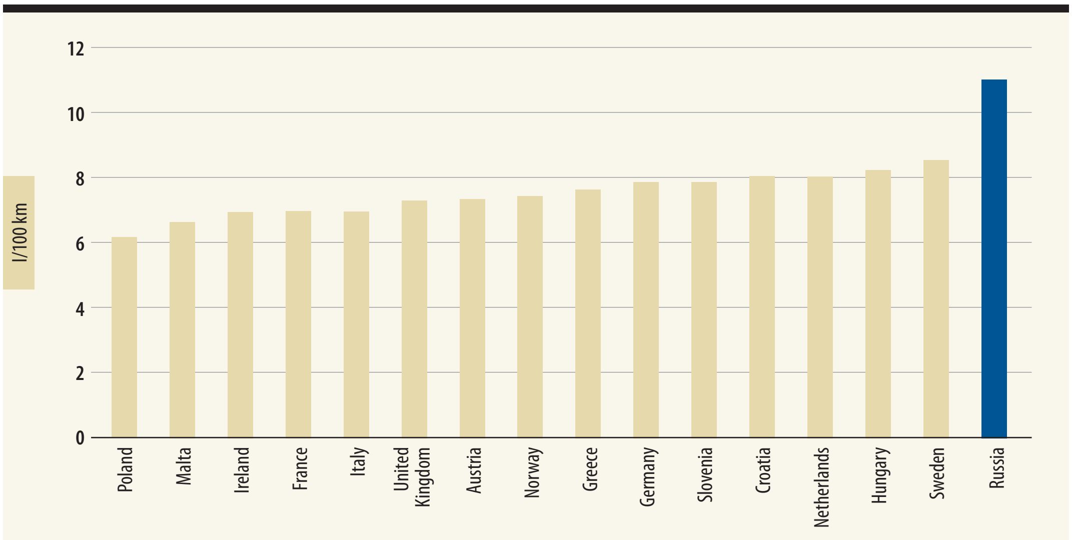
82 As estimated by CENEf for the World Bank. The average nameplate intensity of Russian-made cars is about equal to that of foreign models of similar class, but actual energy intensities of Russian cars is lower. The higher energy intensity of Russian-made engines is offset by lower car power, lower comfort (no air conditioners), and fewer safety features. The growing share of foreign-made cars or foreign car models assembled in Russia on the Russian roads therefore does not significantly influence average car fleet energy intensity in Russia.

83 Ibid.

84 G. Aslanyan, Russia's Energy Efficiency and Indicators, Introduction to Energy Indicators Workshop 26-28 April 2006, International Energy Agency, Paris.

transport. This is a reflection of less efficient vehicles manufactured in Russia (average specific fuel consumption by 1.3-1.5 litre engine VAZ or GAZ is at the minimum 1.5 times higher than that of similar foreign cars), import of used and therefore less efficient cars, as well as growing preference for large cars such as SUVs, in a contrast with European countries.

Figure 45: Comparative Energy Intensities of Passenger Cars, 2004



Source: ODYSSEE for all countries except Russia. Russian data from CENEf.

Most of the investments required to lower energy intensity of petrol-driven vehicles in Russia are economically viable. The incremental cost of investing in hybrid cars is economically viable if drivers travel on average 12,000 km per year (saving 660 liters versus driving the same distance in a Russian car), and assuming the car has a 10-year lifetime. Roughly 40 percent of the technical potential is estimated to be financially viable.

Investments in new heavy-duty diesel-powered trucks could bring savings of roughly 20 percent of 2005 consumption. According to U.S. estimates, investing in new heavy-duty vehicles increases efficiency by 18-24 percent. The incremental cost of achieving a 20 percent increase in efficiency (through investment in new trucks) is economically and financially viable for trucks driven on average 35,000 km per year.

Most of the potential is concentrated in cities and includes savings from increased fuel efficiency of vehicles as well as savings from structural changes (e.g. more public transportation, less driving of personal cars). While there are no reliable data for Russia, expert opinion and comparison with other countries suggests that most road transport traffic, energy consumption and potential for improvement is concentrated within urban areas. In the US, for example, vehicle-miles traveled on urban highways is double that of rural highways.[85] In Thailand, gas consumption in Bangkok is 390 toe per 1,000 people greater than the average gas consumption for the entire country.[86] The consequences of such concentrated fuel consumption and vehicle use are congestion and potentially serious consequences for air quality, human health, and general quality of life in cities.

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85 Bureau of Transportation Statistics. US Department of Transportation.

86 Asia Pacific Energy Research Center, Institute of Energy Economics, Japan. Urban Transport Energy Use in the Pacific Region. 2007.

Rail transport

There is considerable technical potential to improve the energy efficiency of Russia's railroads. Most of the investments are economically and financially viable, or can be achieved with no incremental capital cost for energy efficiency. The technical potential to improve energy efficiency in railroad transportation was assessed at 3.7-4.4 billion kWh of electricity and 0.4-0.5 million tons of diesel fuel. Railroad transport accounts for roughly 7 mtoe of final energy consumption, of which 2.8 mtoe is diesel fuel and 3.9 mtoe electricity.

Much of the investments required to improve energy efficiency in railroads can be made at no incremental capital cost. The replacement and renovation of rolling stock and other equipment is essential for the railroads to continue service. All new railroad vehicles are more efficient than those currently operating in Russia, and therefore none of the new investment would be required for additional energy efficiency *per se.* Roughly 7,000 passenger cars and freight electric locomotives would need to be replaced along with 2,800 diesel locomotives. However, the efficiency gains would be part of, not incremental to these investments. Other investments, which ultimately improve both energy efficiency and system productivity include: the installation of 4,000 IT management systems, the replacement of diesel engines for 1,300 locomotives, the replacement of injection systems for 800 engines, and the installation of fuel meters.[87]

Pipeline transport

Energy consumption by crude oil and refined petroleum product pipelines grew faster than overall commodity throughput during 2000-2005. Official statistics report that the energy intensity of crude oil transportation rose by 76 percent between 2000 and 2005. The energy intensity of refined petroleum products rose by 22 percent during the same time period. Electricity provides most of the energy consumed in transporting crude oil and refined petroleum products. Although losses from natural gas transport were relatively stable during 2000-2005, estimates of Russia's annual natural gas transportation losses (which include losses from leaks, breakdowns, maintenance and repairs, and compressors) range from 1 to 3 percent of all gas transported in Russia.

There is significant technical potential to improve energy efficiency in pipeline transport of Russia's oil, gas and refined petroleum products. Russia's gas and oil pipelines consume 37 percent of all energy consumed in the transportation sector.[88] More than 9 percent of Russia's domestic natural gas consumption is used by gas compressor stations to move the gas to Russian businesses, homes and export markets. Gas consumption by gas pipelines could be reduced by roughly 43 percent, or 15.0 million m^3.[89]

Most investments required to reduce losses in gas pipelines are economically and financially viable. Measures to reduce losses include the installation of systems to "catch" the leaking gas when the compressors are not in operation, low gas emission pneumatic devices (for continuous pneumatic pumping systems), improved audits and maintenance of valves and pipeline surfaces, installation of low gas emission pneumatic devices (for periodic pneumatic pumping systems), sealing rods on alternate/reciprocal compressors, the installation of dry seals on rotary compressors, the installation

87 Assessed by CENEf based on A.V. Kotelnikov (VNIIZhT). Russia's railroads energy strategy. OAO RZhD, 2007. Moscow.

88 Source: 11-TER" statistical form for 2005. Rosstat (2006).

89 Gazprom's estimates of technical potential energy savings are more conservative. Gazprom estimates the technical at 10 bcm, with potential for reduction of losses in the long-distance transportation network of 2.6 bcm, potential for reduction of losses in the mains of 1.08 bcm, and potential for reduction of losses in the distribution systems of 3.68 bcm.

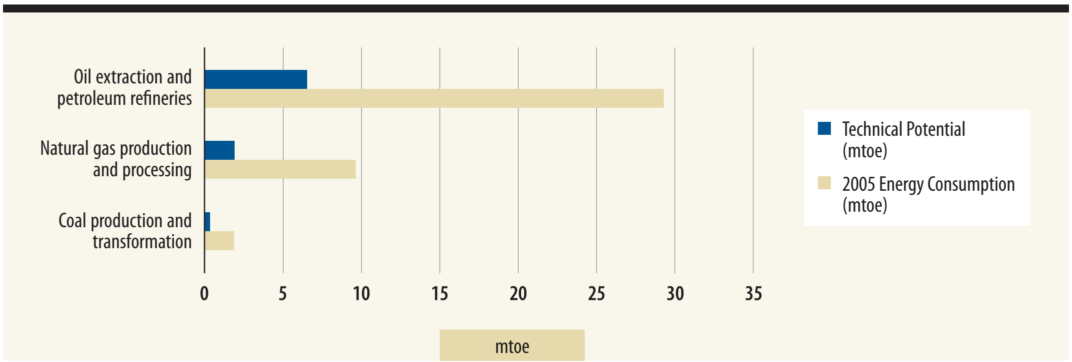
of separators on the associated gas reservoirs, and replacement of compressed air equipment of compressor stations. According to US Environmental Protection Agency assessments based on US practices, such measures may reduce losses by 50 percent.[90]

Energy savings in oil and refined petroleum product pipelines could be achieved by installing more advanced pumps and improving the quality of internal pipe surfaces. According to industry energy managers, a large part of the growth of transport losses in these industries resulted from a higher velocity of oil and products pumping through the overloaded pipeline system. As evidence of this, in 2006, after the pipeline system was expanded, energy intensities decreased by roughly 10 percent. Merely returning to year 2000 energy intensity levels would bring significant energy savings (0.4 mtoe).

4.7 By how much can Russia improve the energy efficiency of fuel production and transformation?

This study estimates the total technical potential for energy efficiency investments in oil production and refining at 4.0-5.6 mtoe; a level of savings equal to roughly 26 to 37 percent of overall petroleum refinery energy use. The combined activities of oil extraction and preparation and petroleum refining are equal to 23.8 mtoe total energy consumption. Figure 46 shows these savings potentials for oil extraction and petroleum refineries, natural gas production and processing, and coal production and transformation. This estimate excludes any reductions in gas use achieved by reducing associated gas flaring in the process of oil production.

Figure 46: Potential to improve energy efficiency in fuel production and transformation



Source: CENEf for the World Bank.

Utilization of APG presently flared in the process of oil production provides enormous potential for improving energy efficiency in Russia. Russian estimates of APG flared in 2006 range from 14 to over 20 bcm.[91] The study sponsored by the World Bank has estimated APG flaring to be higher, at roughly 38 bcm per year. There are several options available to utilize flared gas. These include: gas collection, drying and sale to gas pipelines, reinjection into the producing field to increase oil recovery, using liquid fractions as petrochemical feedstock, use for onsite electricity and heat generation, and generation of electricity for sale to the grid.

90 www.epa.gov/methane/pdfs/macc_analysis.pdf

91 "Presidential gas." Oil and gas. Kommersant. Business guide. 28.08.2007. Pp. 20-21.

The investments required to utilize a large proportion of the flared gas may be economically viable, but are not yet financially viable. Domestic Russian prices are approaching these levels and are expected to exceed them by 2010. International prices for Russian gas are already far above these levels. As Box 2.1 mentions, utilization of just one-third of current flared associated gas at current prices could generate incremental annual revenues of up to $2.3 billion per year.

Coal production and transformation

The potential for reducing energy use in this sector is estimated at 0.26 mtoe, based on a simple assumption that efficiency could be improved by 15 percent. Comparative data in the coal industry are scarce and the ranges of energy efficiencies depend heavily on the characteristics of the deposit being mined.

Natural gas production and processing

The potential for reducing energy consumption at gas fields is estimated at 20 percent, again based on simple assumption. The natural gas supply sector is the largest energy consumer in the country, consuming 42.4 mtoe, or roughly 6.5 percent of Russia's total primary energy supply. Natural gas production and processing consumes 6.8 mtoe energy per year. An additional 2.9 mtoe are lost in transmission and distribution of gas, and 32.7 mtoe are used by gas pipelines. Section 4.6 contains a more detailed analysis of the energy efficiency potential of gas pipelines.

5. HOW CAN RUSSIA IMPROVE ITS ENERGY EFFICIENCY?

Chapter 4 showed many opportunities for the government and individual investors to save both money and energy by investing in energy efficiency. Yet investors, public and private alike, have yet to take full advantage of these cost-saving opportunities because of a number of barriers.

This chapter begins by summarizing the principal barriers to energy efficiency in Russia, as well as possible solutions. In Section 5.1 the focus is on cross-cutting, economy-wide barriers and solutions. Subsequent sections focus on barriers and solutions in specific sectors.

5.1 What are the principal barriers to improved energy efficiency in Russia?

As noted in Section 1, the Russian populous and Russian policymakers have not yet embraced the concept of energy efficiency. As evidence of this fact, there exists no coordinated, defined national energy efficiency strategy or policy, nor any authority responsible for improving energy efficiency. International experience has shown clearly that, in the absence of any concerted national policy and clear political leadership at the highest level, energy efficiency measures are unlikely to enjoy much widespread success.

Russia has shown some intent to make energy efficiency more of a priority, but these efforts have been scattered and without any clear path to implementation. The government has issued a law on energy saving (Federal Law No. 28), included energy efficiency in its energy strategy, and established a Federal Targeted Program on Energy Efficiency (Federal Target Program "Energy Efficient Economy" for 2002-2005, with prospects to extend to 2010). The Federal Law and energy strategy are largely declarative. The Federal Targeted Program focused its funding primarily on the oil, gas and nuclear sectors. In addition, as a result of administrative reforms from 2003-2005, energy efficiency has largely been omitted from the responsibilities of the federal government.

The absence of a cohesive, enforceable strategy for improving energy efficiency in Russia may not be the root cause of energy efficiency in Russia, but it is the most important issue to address in order to initiate and demonstrate the government's commitment to energy efficiency. Without such a strategy, none of the underlying barriers – described in more detail below – have much hope of disappearing.

Little appreciation of energy efficiency

Evidence of a lack of appreciation of the value of energy efficiency can be seen in the culture, values, and social norms of all sectors in Russia. Russian industry managers consistently underestimate the energy savings potential of prospective energy efficiency investments made by their companies and tend to put a greater emphasis on increasing revenues than on cutting costs. Consumers expect a higher rate of return on their energy efficiency investments than they do on other investments. Russian banks rarely lend to energy efficiency projects because they perceive a higher risk. Russian energy providers opt for building new generation capacity over saving energy. Russian regulators do not value the intrinsic energy efficiency benefits of long-term investments in upgrades to utility operations and equipment.

People need motivation and leadership to change their cultural perspective and daily habits. Energy consumption is a passive and invisible process. Most consumers only interact with the costs of their energy usage, and implicitly, the benefits of their energy savings, when they pay their monthly utility bills. As such, consumers tend not to associate their behavior (i.e. their energy consumption) with its relevant costs on a daily basis. Resistance to energy efficient actions is worse in a business, or even public, environment. Many companies are hesitant to adopt practices unless they are generally accepted in the business community and many professionals are hesitant to promote energy efficiency projects without the support of company leaders.

Russian society has yet to reach its energy efficiency "tipping point". People are more likely to follow the lead of those around them. Even when an action, like the adoption of energy efficient measures, has proven personal utility, studies have shown that individuals are more likely to act similarly if they know their neighbors and peers are doing it as well. However, in Russia there is not yet a critical majority that accepts and appreciates the value and benefits of energy efficiency. As a result, the majority of individuals, companies, investors, and public officials are not willing to take the risk of investing time, money, and will power in energy efficiency initiatives. This, however, is doubly harmful to energy efficiency, as the lack of initiative at the individual level creates a society-wide standstill in which there is no consensus that something needs to be done about energy efficiency.

Also pervasive in Russia is the perception that utility services are public goods. These beliefs are neither good nor bad in a moral sense, but may prove impractical if Russia wants to harness its potential for saving energy.

Lack of statistical data and general awareness

Without proper statistics on energy consumption and production at the local, regional, national, and sectoral level, Russia will never be able to fully understand its energy efficiency challenges and potential. Lack of data is a problem in every sector of the Russian economy. Yet realizing Russia's energy efficiency potential is not possible until companies, individuals, producers, and consumers understand the role they play. For example, in Russia's heating sector, no assessment of the heat supply-demand balance exists for cities or regions. Information on heat use by sectors is not analyzed systematically, or, in most cases, is the information even collected because the output of boilers is not generally metered. Likewise, no system exists for gathering and processing the energy consumption statistics of public organizations at either the regional or federal level in Russia. As a result, valuable government budget expenditures are wasted on energy use in public organizations.[92] Without detailed and systematic data reporting, collection, and analysis, producers and end-users will not be able to understand the full benefits they can achieve by saving energy.

A general lack of awareness about energy efficiency among firms and consumers is one of the greatest obstacles to investments in energy efficiency in Russia and throughout the world. This lack of awareness lies at the root of many of the behavioral obstacles described above. Industry professionals and individual consumers alike lack the knowledge required to find and invest in energy efficiency. Russian banks lack sufficient knowledge of energy efficiency investments to offer financing,

92 Public organizations are also often referred to as "budgetary institutions" in Russia.

or at least lack the time – relative to the time required to make other investments – required to understand energy efficiency investments. Russian consumers lack the necessary information on the efficiency of different types of equipment available to their households, and many industrial companies lack the internal expertise necessary to create an energy efficiency investment plan. Even when individuals are aware of the benefits of saving energy, they do not know how to achieve it or where to go for advice. Easily accessible and user-friendly information is the key to increasing the energy efficiency investments and initiatives of individual people and companies.

Dilute incentives or split-incentives

In many sectors, investors have no way to capture the savings from energy efficiency investments. More specifically, incentives to reduce energy use are usually split between numerous actors and those who have the ability or know-how to invest are often not the same as those who benefit from the energy saving measures. Architects and builders pay little attention to energy efficiency because they do not live in the buildings and therefore reap none of the benefits of more energy efficient design and construction. Managers in government-owned utilities show no interest in adopting energy efficiency measures because their performance within the company, and the company's performance within government, is evaluated on standards that inherently discourage measures to improve energy efficiency, or, more generally, any measures which might improve the efficiency of operations and maintenance. Individual apartment owners have no incentive (and often no capital) to repair windows and doors in common areas, even though such measures would allow all owners to reduce energy consumption within their apartments. These are examples only. Many other examples of this "split-incentives" or "dilute incentives" problem can be found in nearly every sector.

Environmental externalities

Environmental pollution, including localized pollution and greenhouse gas emissions, offer a more extreme, but no less relevant example of dilute incentives to improve energy efficiency. Russian energy prices do not include the negative health effects of SOx, and NOx emissions released when energy is consumed. By not accounting for the environmental and health costs associated with energy production and consumption, Russia artificially lowers the cost of consuming energy. Without a system (for example, taxation or a cap and trade system) to effectively capture these negative externalities, Russia will fall short of realizing its full energy efficiency potential. As a signatory to the Kyoto Protocol, Russia also clearly understands the value of reducing carbon emissions, but currently lacks an internal mechanism to recognize the costs of such emissions to society.

To some extent, social values in Russia also present an obstacle to improving energy efficiency. Environmental concerns do not have the same affect on behavior in Russia as they do in other countries. Consumers in some European countries, for example, will implicitly price in the value of environmental externalities. Environmentally-conscious consumers will curtail their consumption even when the price they pay for energy is not the principal driver of this behavior.

Tariff methodologies and tariffs

The way in which tariffs are set, and the level, structure, and design of Russia's utility tariffs discourage energy efficient behavior by energy consumers and energy producers. As a recent *Economist* article noted, "In the eyes of many consumers, electricity and fuel are often too cheap to be worth saving, especially in countries where prices are subsidized."[93] In Russia, more specifically:

- The current "cost plus" tariff methodology used in many sectors provides an incentive for utilities to increase rather than decrease operating and maintenance (O&M) expenditures.

[93] "Energy Efficiency: The Elusive Negawatt." *The Economist*. May 8 2008.

The tariff structure, in which customers pay a volumetric tariff, without a fixed cost component, further discourages utilities from reducing loads because they risk not recovering all of their fixed costs.

- Customer tariff levels are below the long-term sustainable cost of production and delivery. Tariff structures allow for continued cross-subsidization of residential customers with revenues from larger customers. Moreover, tariff design, in some cases, remains based on norms (for example, the size of the customer's dwelling served, or the number of residents in the customer's dwelling served) rather than actual consumption.

Increasing the cost of energy to consumers is a politically and socially contentious policy move, but continuing to subsidize energy prices for every consumer, across the board, is not a sustainable practice for the Russian government in the long-run. The government is well aware of these issues, and is taking steps to gradually raise the tariffs, and pilot alternative tariff methodologies.

High transaction costs

High transaction costs often hamper access to financing and project completion for many small energy efficiency projects. Financial institutions evaluate transaction costs when deciding whether or not to finance energy efficiency projects. Typically, transaction costs refer to the cost burden born as a result of each financing operation, which can include the up-front costs incurred to get a program started or the loan-by-loan administrative costs for a line of financing operations. Other transaction costs can be associated with information processing and with structuring deals to control the transaction. High transaction costs for financial institutions can eat away their profits. Hence, when energy efficiency transactions are small and scattered, banks are not motivated to develop financing for such projects. More generally, transaction costs hinder energy efficiency among all end-users due to the small-size of improvements and small-returns of many energy efficiency investments. Irrespective of cost, the number of improvements needed to realize substantial energy savings may require too much time, knowledge, and effort to make energy efficiency investments "worth it" for many end-users.

Lack of competition

The exclusive rights of supply granted to Russia's large energy suppliers undoubtedly stifle energy efficiency in the country. As indicated in Section 1, Russia frequently receives recommendations on the need for greater competition, enveloped in messages about energy efficiency. The message of this report is more direct. Competition is not an end in itself, but a means to improving energy efficiency, and with it, national welfare in Russia. Russia will not be able to reap the gains of energy efficiency without allowing for greater competition in energy production and supply. Monopolies or oligopolies in the oil, gas, and electricity sectors severely limit Russia's ability to tap into its energy efficiency potential.

Moreover, some vestiges of Soviet central planning persist in Russia's energy sector. The perceived need for widespread government ownership and operation of energy companies is one example of this heritage. Government ownership *per se* is not problematic if governance is good enough to encourage efficiency and superior performance. Evidence suggests, however, that competition is better at encouraging efficiency and performance, and that competition is more difficult to implement when the government has a direct financial stake in a particular sector and is involved in the management of companies.

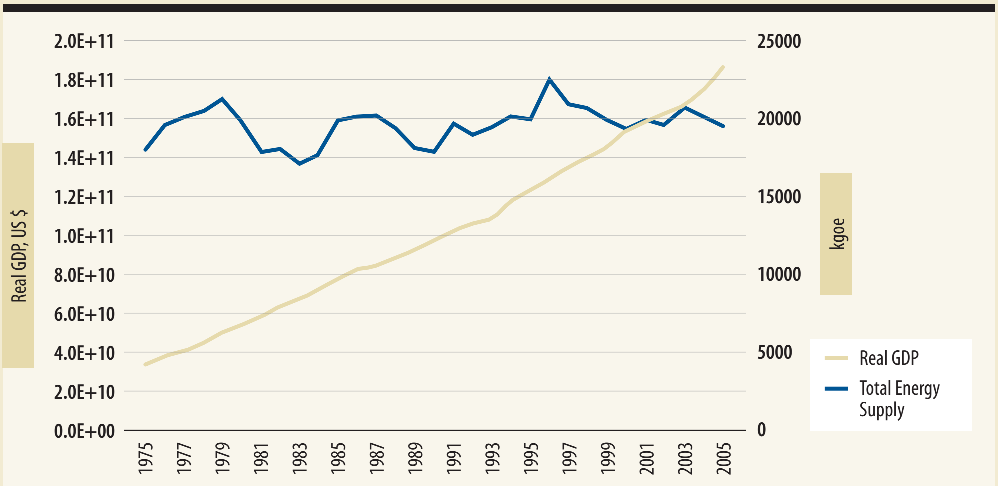
5.2 What can Russia do to overcome these obstacles?

There are signs that substantial political leadership now exists in Russia to tackle the country's energy efficiency challenges. As noted in previous sections, Former President and current Prime Minister Vladimir Putin has indicated that under Russia's leadership of the G8, the summit will prioritize the topic of energy efficiency. He has also clearly indicated the need to increase energy tariffs for regulated services (electricity, gas, and heating) to full cost-recovery levels. Since his inauguration, President Medvedev has also made several public statements identifying Russia's inefficient use of energy, and the associated economic and ecological consequences. If such high level leadership is translated into policy, the policy implemented as law, and the laws implemented in the form of funding or enforceable regulations, Russia may well be able to effectively reduce its energy intensity.

Concerted and coordinated action will be required on the part of Russian policymakers if Russia is to achieve its energy savings potential. Experience from countries like Denmark (see Box 5.1) have, in particular, shown the importance of political will and coordinated action in creating a national ethos geared toward energy saving.

Box 5.1: The importance of political will and coordinated action in Denmark

Denmark responded to the 1970s oil crises with a massive national initiative, and has, as a result, made impressive improvements in energy efficiency. Denmark has managed to double its GDP since the oil crisis, while keeping energy consumption relatively flat and significantly reducing energy intensity and CO_2 emissions.



At the time of the first oil embargo, Denmark was 99 percent dependent on foreign oil. The crisis led the country to develop a broad based strategy to reduce its dependence on fossil fuels. Taxes were increased on natural gas and petroleum to reduce consumption, and new initiatives helped develop new sources of energy. These efforts eventually allowed the country to lower the national debt, have a healthier environment, and be less oil dependent. Government policies have enabled homes and buildings to be warmed by surplus heat from power plants. Consumers do their part by heavily utilizing public transportation, buying energy efficient appliances, and building their homes with thick insulation.

These efforts have made Denmark's energy consumption per unit of gross domestic product the lowest in the European Union, as well as the country with the highest proportion of electricity generated by renewable sources.

Sources: Abboud, Leila. "How Denmark Paved Way to Energy Independence." *Wall Street Journal*. 18 April 2007. Energy consumption data from the International Energy Agency (IEA), Energy Balances data set.

It is important that the Russian government enact certain policy measures first in order to most effectively initiate coordinated and systematic action on energy efficiency. Specifically, establishing a dedicated energy efficiency agency and improving energy data collection in all sectors must be done before other policy measures can be implemented effectively. Many other government actions will require sector-specific analysis and solutions. These solutions differ considerably in the time and cost required to implement them and in the impact they can have in improving energy efficiency. Sections 5.3 through 5.9 therefore prioritize the recommendations based on whether they are "quick wins", "essential", or "high cost, high return". These labels capture attributes of preparation time, cost of implementation, and impact. More specifically:

Quick Wins are those interventions which can be introduced in less than a year and are likely to produce significant impact at moderate cost, such as:

- Energy efficiency information awareness campaign
- Flexible budgeting and procurement rules in public organizations
- Transformation of municipal heat suppliers into commercial entities

Essentials are interventions which form the backbone of a comprehensive energy efficiency policy, affecting the areas of greatest potential by raising standards and enabling investment, such as:

- Energy efficiency standards in areas such as buildings, industrial equipment, fuel efficiency
- Demand side management
- Energy efficiency as a condition for subsidy in capital renovation
- Coordinated heat supply plans
- Facilitated financing through financial institutions

High Cost, High Return interventions carry a much higher initial cost to the economy, but most of them have a high return in terms of energy savings and can increase the financial potential for many energy efficiency investments that are currently financially unviable. In addition, these measures are critical to ensuring long lasting impact and sustainability, such as:

- Tariff reform
- Liberalization of electricity and gas market
- Integrated transport planning
- Charging the full cost of vehicle usage.

Many of the solutions discussed in Sections 5.3 through 5.9 require sector-specific analysis and implementation, but share an approach common to many sectors. These cross-sectoral approaches are discussed briefly below, before proceeding to a detailed discussion of sector-specific barriers and solutions.

Establishment of an energy efficiency champion

Dedicated government agencies for energy efficiency have become an increasingly common way to coordinate government action on energy efficiency. At the federal level in Russia, the responsibility for energy efficiency policy has been moving from one agency to another, resulting in a general lack of ownership of the agenda. While the late 1990s saw several good-faith attempts to raise the profile of energy efficiency, today Russia's energy efficiency policy is once again fragmented and lacking clear ownership. Russia may want to consider designating an energy efficiency champion, which may include creating a separate office of energy efficiency within the country.

In a survey conducted by the World Energy Council, roughly two-thirds of countries surveyed have a national energy efficiency agency and over 90 percent a Ministry department dedicated to energy efficiency. Energy efficiency agencies aid in promoting energy efficiency policies by designing, implementing and evaluating programs and measures that involve a range of stakeholders, including companies, NGOs, and local authorities. Generally, these agencies are public institutions funded through the federal budget, a tax on energy, or, in the case of some developing countries, overseas technical assistance funds. Whether Russia chooses to organize an energy efficiency champion as a separate agency, a department within a ministry, or through some other arrangement (i.e. a national project), the functions of the program should include:

- Providing technical expertise to the government and consumers. This is primarily done by creating and supervising a system for certifying the quality of energy efficiency equipment and services.
- Advising the government and sector regulators on legal and regulatory policy to improve energy efficiency.
- Coordinating government initiatives in the field of energy efficiency. Dedicated agencies help to avoid scattered, uncoordinated, and overlapping efforts by multiple ministries.
- Negotiating financial packages for energy efficiency with international financial institutions. Such agencies can serve as the arbiter between IFIs and the government to implement financial assistance and even develop new funding schemes for energy efficiency.[94]

Statistical data gathering

Systematic and comprehensive data gathering is crucial to the adoption of energy efficient practices and investments in Russia. The statistics office and line ministries need to develop uniform and user-friendly methods for recording, reporting, and aggregating individual, firm, sector-wide, and regional data on energy production and consumption. Local government can also be instrumental in this process by facilitating and managing data gathering in a more detailed manner. This information is vital in developing benchmarking and best practices guidelines to demonstrate the potential benefits of energy efficiency investments to end-users. IEAs planned cooperation with the Russia Statistical office can be instrumental in putting in place a comprehensive data gathering system.

Information dissemination

Individual households, companies, and public organizations need to be equipped with the know-how and provided the expertise to carry out energy efficiency investments. In addition, information dissemination can raise general public awareness and acceptance of energy efficiency practices as necessary and socially beneficial decisions. Information dissemination campaigns can come in multiple forms, but need to be tailored to the end-user in order to be effective. Such campaigns can include: advertising campaigns on energy efficiency, energy labeling of appliances and equipment, advice on equipment and behavioral practices, education at schools, and interactive expert advice through audits. Whether or not the government is directly involved in the information dissemination, such campaigns are often funded with government support. Box 5.2 describes how behavior towards environmental regulation and carbon taxes changed in Sweden.

Box 5.2: Changing behavior through information dissemination in Sweden

Sustained policy efforts coupled with information campaigns that tap into the Swedish national identity have allowed Sweden to become a global frontrunner in reducing energy consumption and tackling climate change. Sweden introduced a CO_2 tax that has been gradually raised since its introduction in 1991. The government estimates that CO_2 emissions would be 20 percent higher had taxes remained at 1990 levels. Swedish regulators met initial opposition from the business community; however, as the link between these taxes and the competitive edge gained from environmental progressiveness became clearer, the business community began to buy in. As Andreas Carlgren, the Swedish Minister for the Environment, describes, "they [the business community] said this is really a part of what gives us opportunities in competition and what really makes us strong in competitiveness. . . Today, the main experience is that the business community is really in favor of quite progressive environmental action."

Part of Sweden's success in changing behavior comes from who the target audience is for many of their environment-friendly campaigns: Swedish youth. As Calgren explains, "Many of the Swedish preschools are engaged in taking children into nature, giving them experience of nature. I think that's also part of the everyday life of most Swedes." At Global College, a public upper secondary school in central Stockholm, teaching is focused on enhancing students understanding that their future must be built on sustainable development. Such support for creating environmentally conscious and concerned students is projected in the Swedish society at large. Progressive environmental action is now a part of the Swedish tradition and national identity.

Source: Yamamori, Yuka. *Sweden Offers Glimpse of Sustainable Future.* Jiji Press, Ltd. 27 May 2008.

94 *Energy Efficiency Policies around the World: Review and Evaluation.* World Energy Council: 2008. 38-40.

Energy efficiency standards

Many obstacles hindering the full adoption of energy efficiency initiatives can be overcome by the creation and enforcement of mandatory standards. The development and enforcement of standards provides end-users with reliable data that helps to guarantee the benefits of their energy efficiency investment. Similarly, standards help to reduce the risk for financiers by assuring a certain quality level for the investment. Standards also can alleviate the split-incentive problem by mandating certain criteria for various actors in the product's (e.g., appliance, equipment, or building) value chain.

Standards must be developed to allow flexibility for revision. Energy efficient technologies are constantly being updated and standards should be continuously revised to reflect these changes. Moreover, standards must enjoy widespread and systematic enforcement in order to be effective. Voluntary standards do little to encourage widespread adoption of energy efficient practices and the ambivalent perception of energy efficiency in Russia suggests that few individuals or companies will take this initiative on their own. Sector-specific recommendations on standards will be elaborated in the subsections to follow.

It is also important for Russia to recognize the limits of mandatory standards. If mandatory standards allow for excessive intrusion into the economic decisions of private firms or households, they risk simply becoming opportunities for the government to interfere. In such cases, the standards may prove better at promoting rent seeking by government officials than promoting energy efficiency.

Promotion of energy performance contracts (EPCs)

Energy performance contracts (EPCs) can play a significant role in helping Russia to improve its energy efficiency. EPCs allow specialist third party contractors to take on responsibility for helping an organization – a private firm, public organization, or apartment building – save energy by taking on some of the financing responsibility for capital repairs and providing the technical expertise to achieve energy savings, in return for a fixed fee or a share of the money saved. The use of EPCs can help solve many of the informational and split/dilute incentives obstacles to investing in energy efficiency in Russia.

EPCs are commonly associated with Energy Service Companies (ESCOs) Box 5.3 summarizes how ESCOs function. ESCOs can help stimulate energy efficiency investments, but have proven difficult to establish without proper government support and regulation. ESCOs have been successful in the US and Canada, but only with significant government support, and in China but only with substantial World Bank and government backing. In contrast, ESCOs have enjoyed only limited success in Europe with a few exceptions like Germany.

The use of EPCs does not need the relatively expensive institutional foundations created for ESCOs in countries like the US and China. The use of EPCs, rather than the creation of an ESCO industry per se, is a better idea for Russia. It is ultimately more important for the government to provide incentives for organizations to strike EPC-like contracts with private firms, specialist non-profit organizations, or even with their own employees. As will be discussed in more detail below, EPC contracts can be particularly effective in addressing the barriers to energy efficiency in public organizations.

Box 5.3: Overview of ESCOs

Energy Service Companies (ESCOs) are firms that provide technical assistance and sometimes financial support in order to lower the transaction costs of energy efficiency investments. The companies use their expertise in the design and implementation of energy efficiency projects to guarantee energy savings for their clients from the investment. This guarantee is formalized in an energy performance contract (EPC). Benefits of ESCOs have been evident mainly in small projects and specific segments of the market where the technical expertise they provide is necessary. Taking on such roles as engineer, project manager, financier, and guarantor, ESCOs act as a catalyst for energy efficiency projects by removing barriers to investments.

The parameters of the EPC depend on whether or not the ESCO is financing the project. Due to the small firm size and technical nature of many of these projects many financial institutions are wary of making loans. In these instances, the ESCO, which is a larger, more financially stable firm, procures a loan and funds the project itself. Repayment by the client to the ESCO is based on a share of the cost savings as a result of the energy efficiency investment. The ESCO in turn passes on a portion of this share to the bank in order to repay the loan. This agreement appeases the client because they are only obligated to pay for the project using the savings they achieve from its success, while also providing assurance that the ESCO will make a worthwhile investment.

In other EPCs, the ESCO does not act as the financier. Instead, the client acquires funds directly from a financial institution and pays the ESCO for design and implementation of the project. As part of the EPC the ESCO guarantees cost savings over a defined period. If the cost savings are not reached the ESCO will refund all or part of the payments they have received. Even though the ESCO does not fund the project directly, as a guarantor of the project's success they indirectly play a role in financing as both the financial institution and client enter into their agreement with an understanding of this insurance.

ESCOs with financier-like capabilities are more feasible in countries still in the process of developing energy efficiency projects. This is primarily due to the ESCO's greater ability to obtain loans. Often, however, ESCOs require government support since they represent a deviation from normal business practice and firms need incentives and assurance of the new market. The United States and Canada were successful in this endeavor by promoting programs in support of energy efficiency renovation, which created a market for ESCO services. Additionally, as ESCOs and energy efficient investment become more common, the availability of direct loans to end user clients increases. Consequently, with this transition the guarantee model EPC becomes the common agreement.

It is important to note that ESCOs are not the sole solution to energy efficiency investment. These companies are susceptible to the same risk calculation by financial institutions as their clients. Even for ESCOs, a high level of technical knowledge and capital backing is necessary in order to qualify for loans. These standards limit entry into the ESCO market and can deem them a less than optimal solution without proper incentives and support.

Source: Taylor, Robert P., Chandrasekar Govindarajalu, Jeremy Levin, Anke S. Meyer and William A. Ward. "Financing Energy Efficiency: Lessons from Brazil, China, India, and Beyond." World Bank, 2008. p. 131-138.

Continuation of tariff reforms

The government is right to continue the electricity tariff reforms as it moves toward greater sector liberalization. On May 8, 2008, former Russian President Vladimir Putin announced that by 2011 Russia will have transitioned to long-run marginal cost tariffs in energy networks in every region in the country.[95] Tariff reform is about recognizing a utility's true cost of service. Measures that ensure customers incur the full cost of the resources they consume are essential for bringing about energy savings. Among American states, for every cent per kilowatt-hour by which prices exceed the national average, energy consumption drops by about 7 percent off the average.[96] For example, in California, where electricity rates are eighth highest in the nation, consumption has stayed relative flat over the past 30 years at about 7,000 kWh per year, while U.S. consumption per person climbed 50 percent and is now roughly 12,300 kWh per year.[97]

In Russia, this will mean not just higher tariffs but also the introduction of different tariff structures and charges which specifically encourage energy efficiency:

- Reforming how the utility recovers its cost of service through tariffs. The tariff level, tariff schedule (customer classification), and tariff design (for example, a "one part" or "two parts" tariff) must reflect as closely as possible the costs as the utility incurs them. In Russia, this

95 Transcript of Meeting of the Russian Federation State Duma. Moscow. May 8, 2008. http://www.kremlin.ru/

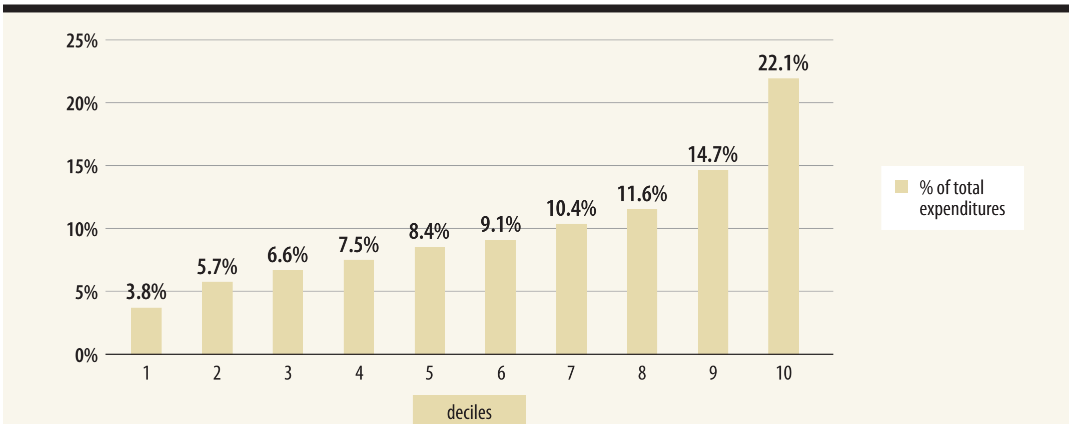
96 "Energy Efficiency: The Elusive Negawatt." *The Economist.* May 8 2008.

97 Lavelle, Marianne. "When Saving Power Means Higher Profits." U.S. News & World Report. 28 April 2008. 48.

means phasing out customer cross-subsidization, and introducing volumetric tariffs where consumption norms (for example, in the heating sector where consumption is determined by the size of the customer's apartment) are still used. Widespread metering is obviously required in order for utilities to be able to implement this recommendation

- Reforming how the cost of service is determined. The way in which cost-plus regulation is implemented in Russia discourages any improvements in operating and maintenance efficiency, and discourages capital investments even if those investments may yield cost savings for customers over time. More generally, utility regulation – in Russia as in most other parts of the world – historically gives energy utilities an inherent incentive to build more production capacity, and sell more energy, rather than save it. In the face of rising energy prices, many regulators are now looking for ways to change this incentive, by "decoupling" profits from energy sales
- Elimination of across the board subsidies. The Russian government imparts tariff subsidies in order to maintain the affordability of energy for all members of society. However, due to higher levels of consumption among wealthier consumers, the non-poor tend to benefit much more from tariff subsidies than the poor. This is demonstrated by the fact that the poorest 20 percent of the Russian population consumes less than 10 percent of utilities while the wealthiest 30 percent consume roughly 48 percent of utilities. As a result, less than 10 percent of these subsidies go to the poorest and almost half go the wealthiest of the population. The same lack of discretion applies to industry where companies that do not need subsidies benefit as much as those that do need them.

Figure 47: Utilities Expenditures by Consumption Deciles



Source: Rosstat, Worldbank's "Russian Economic Report" #16 and "Poverty Diagnostic" (2008, forthcoming).

Tariff reform is necessary in order for Russia to become energy efficient. However, a poorly managed transition to higher energy prices could have severe political and social consequences. This should not deter policymakers from making necessary reforms but suggests that caution should be used so as to plan tariff reforms in a way that cushions the impact on households and poorer segments of the population. Tariff reforms coupled by targeted subsidies will allow prices to transition to a cost-recovery level, while ensuring that those who are least able to absorb the price increases are compensated accordingly.

Demand Side Management

Demand Side Management (DSM) encompasses a range of measures designed to reduce customer energy usage, or change the times when customers use energy. Such programs are typically executed by utilities, government agencies, or third party organizations, under the force of government regulation. DSM programs can take various routes towards encouraging efficient energy use among customers. Programs that are designed to realize economically viable energy efficiency opportunities for customers will, for example, pay customers to change out light bulbs or upgrade heating and air conditioning systems. Other programs seek to understand barriers, many of which are discussed in this report, to customer utilization of energy efficient devices, appliances, processes, or measures, and use funds to permanently alter or remove those barriers. For example, a program designed to encourage the distribution of efficient water heaters would keep highly efficient models on hand and encourage their sales when customers call for replacement.[98] More information on how Russia might implement DSM is included in the discussion of solutions for the electricity sector, below.

Taxation or "cap-and-trade" scheme for pollutants

Russian producers and end-users alike need to be responsible for the negative consequences of their energy production and consumption. Ultimately, someone has to bear these costs. If Russia does not have a system in place for passing the costs of externalities on to responsible parties, the government will likely have to bear the consequences in the form of greater long-term costs of energy in public expenditure budgets, higher subsidies to energy efficiency investments, and decreased social welfare.

Carbon tax schemes and "cap-and-trade" schemes are the two most commonly used methods for capturing the externalities of greenhouse gas emissions. Each has their advantages and disadvantages. Cap-and-trade mechanisms have been particularly successful in limiting NOx and SOx pollution in parts of the United States. Box 5.4 describes this experience.

Box 5.4: Cap-and-Trade Regime for NO_X and SO_X in the US

In order to curb the harmful health and environmental effects of acid rain, which results from sulfur dioxide (SO_2) and nitrogen oxides (NO_X) emissions, the U.S. Congress established the Acid Rain Program in the 1990 Clean Air Act. Under the program, the U.S. EPA implemented a market-based cap and trade mechanism in order to reduce SO_2 emissions by 10 million tons, or roughly half of the amount of SO_2 emitted in 1980. To achieve the reduction, the Act required a two-phase tightening of restrictions placed on fossil fuel-fired power plants. The Act also called for a two million ton reduction in NO_X emission by the year 2000.

The basic elements of the cap and trade program included:

- **Mandatory cap on emissions.** The EPA set a limit on the total tons of emissions that could be emitted. This provided a standard by which progress could be measured and allocated market value to trading tons of pollution.
- **Fixed number of allowances.** Each polluting entity was allocated a fixed number of allowances giving them the right to emit one ton of pollution at any time.
- **Banking and trading.** By reducing emissions below allowance levels, polluting entities could sell their extra allowances. Conversely, a polluter that deemed a reduction in emissions too expensive could purchase allowances from another source. Buyers and sellers also had the ability to "bank" allowances for future use.
- **Monitoring.** Accuracy, consistency and transparency of data gathering and reporting of emissions levels were vital to the success of the allowance trading system and achieving the targeted reduction.

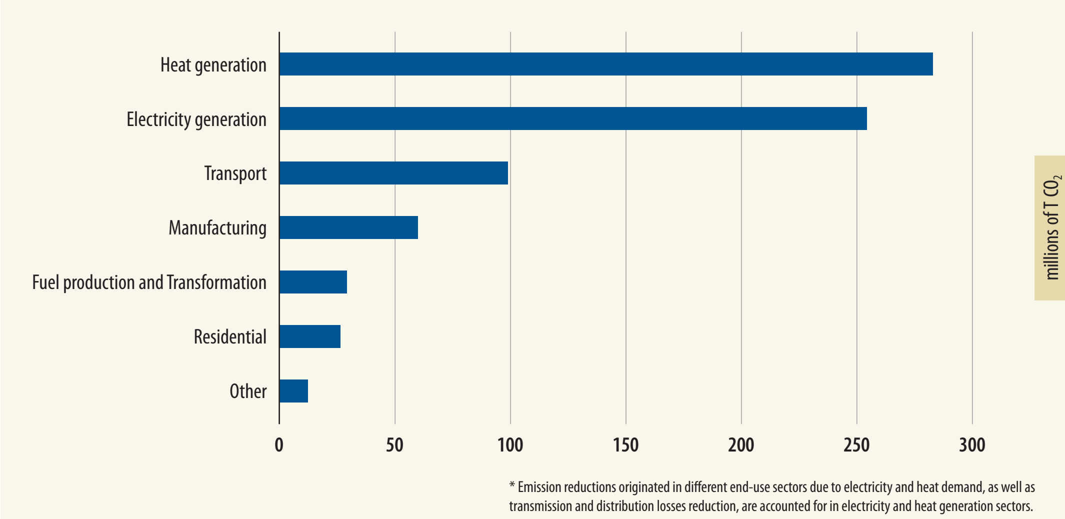
In 2002, *The Economist* deemed the Acid Rain Program "probably the greatest green success story of the past decade." The program achieved 100 percent compliance in reducing SO_2 emissions below 1980 levels, and some power plants achieved reductions 22 percent below their mandated levels. Additionally, the program was much less costly than was originally anticipated. Before the launch of the program, SO_2 allowances were expected to cost in the range of $579-$1,935 per ton of SO_2. As of January 2003 actual market prices for SO_2 allowances were $150 per ton. Overall the program was estimated to cost between $3 and $25 billion per year, but after the first two years, costs were only $0.8 billion per year. Since 1994, over 222 million allowances have been transferred and over 43,000 transactions have taken place. Roughly 98 percent of those transfers took place online, resulting in very low transaction costs to participating entities.

Sources: "The Cap and Trade Success Story." The Environmental Defense Fund. September 17, 2007. http://www.edf.org/page.cfm?tagID=1085.
"Acid Rain Program: Basic Information." U.S. EPA Clean Air Markets. http://www.epa.gov/airmarkets/progsregs/arp/basic.html
McLean, Brian. *Experience with Acid Rain and NO_X Cap and Trade Programs.* Office of Atmosphere Programs, U.S. EPA. February 27, 2007.

[98] Harrington, Cheryl. "Who Should Deliver Ratepayer Funded Energy Efficiency?" The Regulatory Assistance Project. May 2003.

Moreover, as Russia's current emissions are considerably lower than Kyoto Protocol levels and will likely remain so until and even after 2012, the country could be in a position to sell its surplus – some 3 billion tons for the period 2008-2012 – on the international carbon market. Figure 48 shows Russia's CO_2 reduction potential. The revenues from these sales could be used to attract much-needed investments in infrastructure and the energy sector, particularly in energy efficiency. Box 5.5 describes how Russia could generate energy efficiency investment funds by selling its carbon credit surplus.

Figure 48: Russia's CO_2 reduction potential



Source: CENEf for the World Bank.

Box 5.5: Selling surplus carbon credits in Russia

The greenhouse gas emissions from Russia's economy are today much lower (and will stay much lower for the next 10 years) than in 1991. The difference between the 1991 level and today's level is called "headroom" and is measured in "Assigned Amount Units (AAU)". There are several countries, notably Japan and Spain, which have expressed interest in buying surplus AAUs from Russia as long as these AAUs are "greened". In order to "green" AAUs, the proceeds of the sale of the AAUs must be invested in emission reduction projects and programs. Ideally, Russia needs a mechanism in place in order to green these credits beyond 2012. One possible mechanism to oversee the process of "greening" AAUs is the Economy Modernization Fund (EMF). The EMF could be administered by the World Bank in order to provide comfort to buyers who want to ensure the "green integrity" of the Fund. The EMF would function as follows:

- The Fund will have priority areas as well as mechanism for estimating the emissions reductions that could be achieved through the identified measures. Areas of support could be:
  - Modernization of public infrastructure like district heating systems in Russian cities and gas distribution;
  - Energy Efficiency measures in electricity generation and supply;
  - Coal mine modernization and usage of coal mine methane;
  - Development of alternative energies.
- The World Bank, in close cooperation with its Russian counterparts, would identify and discuss the sale of AAUs with potential buyers.
- The Russian government would make available 50-100 million AAUs and would place them in the Economy Modernization Fund. The 50-100 million AAUs could have a value of some €500-1000 million.

Transaction cost support to financial institutions

Several efforts can be made to mediate the effects of transaction costs on energy efficiency investments. Similar projects can be aggregated and bundled into one financing package or can be replicated in a large number of similar enterprises or situations. Another solution used by banks in many countries is clustering. The cluster approach can bring specialized technical support and outreach to smaller enterprises along with follow-up loan provision based on a standardized, replicable model that can result in substantial reductions in transaction costs per loan. In addition, there are a few simple "public goods" kinds of steps that can be taken by governments or by industry groups, including the following:

- **Use of strong and credible expertise.** Financiers and end users place a high value on having agents with good reputations from past experience provide technical expertise. Developing a cadre of agents certified by the government or another apex agency provides a certain level of comfort to the end users and financiers, and can reduce costs associated with verification of claimed savings from proposed projects.
- **Provision of concessional finance** to subsidize initially high transaction costs during development phases, to buy down risks involved in program startup, to develop and pilot new approaches and products, and to develop the wide range of capacities needed for program implementation.
- **Assistance to the participating financial institutions in refining and standardizing loan applications/appraisal procedures.** This requires specialized technical assistance to each individual bank and follow-up training assistance.
- **Intensive support to the local bank branches in marketing and refining their energy efficiency lending schemes.** This work includes dissemination of information about schemes to energy efficiency project developers and client enterprises.[99]

5.3 What are the barriers and solutions to improving energy efficiency in Russia's residential buildings?

As the second largest end-user of energy in Russia, the residential housing sector has the greatest energy savings potential. Energy savings as a result of investments in the housing sector are even greater because of the multiplier effect discussed in Chapter 4.

Figure 49 shows some of the principal barriers in the residential sector, and solutions to those barriers prioritized based on impact, preparation time and cost of implementation. These barriers and solutions are discussed in more detail in Sections 5.3.1 and 5.3.2, respectively. Some of the most significant barriers to energy efficiency in the residential sector relate to the wide array of actors involved in the construction, management, and use of buildings. All have the ability to influence how energy is consumed within the buildings, but few have the incentive. Those that might have the incentive are not well placed to know what investments might save energy, and if they did know, do not have the means to pay for or finance those investments. These barriers, however, are inherent to the residential housing sector nearly everywhere in the world. Significant barriers specific to Russia are: (as mentioned in section 5.1) the low tariffs faced by household customers, a lack of enforcement of existing federal standards for new construction, and a lack of awareness or appreciation for energy efficiency among homeowners, which ultimately drives their behavior. To add to the complexity, barriers and solutions often differ depending on the vintage of the building and whether the energy efficiency measures involve new construction, reconstruction, or capital repairs.

[99] R. Taylor et al. *Financing Energy Efficiency, Lessons from Brazil, China, India and Beyond.* World Bank 2008.

Solutions for these barriers require, first and foremost, the enforcement of energy efficiency standards where they exist, and the creation of standards where they do not exist. Additional gains can be made through better collection of energy consumption data on residential buildings, and better dissemination of information to homeowners. There may also be room to use EPCs in conjunction with Homeowners Associations (HoAs) or building management companies.

Figure 49: Barriers and Solutions to Energy Efficiency in Residential Housing

Barriers	Solutions	
■ Apartment owners or building managers have little information on EE ■ Construction and thermal insulation standards will become voluntary in 2010 ■ Developers and their contractors have no incentive to improve EE ■ Apartment owners have no incentive to invest in EE ■ Apartment owners have limited access to capital to make EE investments	Quick Wins	■ Disseminate information on energy efficiency ■ Make existing energy efficiency standards mandatory for the construction and renovation of buildings and monitor energy efficiency of buildings in use
	Essentials	■ Require that energy efficiency improvements be made as a condition of government financial support for capital repairs ■ Provide incentives for more widespread metering ■ Develop standardized performance-based management contracts for HOAs and building management companies ■ Establish a capital repairs loan guarantee facility ■ Introduce energy efficiency standards and labeling for lighting and household appliances

5.3.1 What is hindering energy efficiency investments in the residential sector?

The barriers and solutions for improving energy efficiency in residential buildings differ substantially depending on the age of the building. The barriers for new construction and existing buildings are therefore discussed separately below.

New buildings

For new buildings, the principal barriers to energy efficiency are that:

- **Developers and their contractors have no incentive to improve energy efficiency.** Developers, their financiers and contractors (architects, builders, material and equipment suppliers) have control over the energy efficiency of the structures they build, but because they do not live in the building, and do not pay the energy bills, have no incentive to improve the structure's energy efficiency
- **Thermal performance standards will become voluntary in 2010.** The Federal Law on Technical Regulation of 2003 provided for all federal standards in Russia to become voluntary in 2010. Developers and their contractors will therefore face no requirement (and as described above, no incentive) to use techniques that improve a building's energy efficiency. Furthermore, many regions are still lacking well-developed and transparent procedures to ensure compliance with the existing standards
- **Developers and their contractors have limited knowledge of energy efficiency.** Studies in Russia have shown no correlation between higher costs and the use of energy efficient technologies.[100] Many construction firms still do not utilize these technologies because they lack knowledge of new technologies and lack proper training to implement new technologies. Even when firms are aware of these technologies, many are unwilling to change business as usual and hesitant to adopt new technologies.

[100] CENEf.

Existing buildings

In existing buildings, the principle barriers to energy efficiency are that:

- **Energy efficiency is not monitored.** At present there is no agency in Russia that monitors energy efficiency in residential buildings. As a result it is difficult to assess the need for energy efficiency retrofits and the specific measures that need to be undertaken during reconstruction, modernization or capital repairs of the buildings

  Lack of data and improper analysis proved particularly detrimental to a capital repairs project in Norilsk. The program financed insulation measures in a number of municipal buildings. However, a post-implementation assessment revealed that improper selection and design criteria led to investments in the wrong buildings. As a result of poor prioritization of buildings, technologies used and solutions provided, the capital repair investments were in many cases ineffective

- **Apartment owners or building managers have little information on energy efficiency.** Apartment owners, homeowners associations, and local authorities lack the data and information they need to make energy efficiency investments. There is, specifically, a dearth of information on:

  - Household energy use. Metering of energy use, particularly of heat, is scarce. Very little metering exists at municipal boilers or at the buildings that receive heat supply. Most customers therefore pay for heat supply on a normative consumption basis (usually, per m^2 of their apartment's floor space, or per apartment inhabitant). Actual consumption of heat in a building tends to differ substantially from consumption estimated on a normative basis. Consumers also typically have no way to control their supply of heat (neither at the building nor apartment level), often because of the vertical, single pipe design of heating systems in many buildings. Because of this lack of control, and for other reasons discussed in Section 5.6, Russia's apartment buildings are often overheated, leaving ventilation (opening windows in mid-winter) as the only option for keeping rooms a comfortable temperature
  - The best measures or investments to improve energy efficiency, and the energy savings potential of such measures or investments. The majority of residents are unaware of the effectiveness of simple and affordable insulation measures, such as installation of heat-reflecting screens, adhesion of low-emission film on windows or the use of modern infiltration prevention materials. Weatherization of buildings and installation of triple-pane windows alone can reduce heating energy consumption by 40%.

- **Apartment owners have limited access to capital to make energy efficiency investments.** Consumer loans in Russia typically have short terms (1-2 years) and high interest rates. Often low-income households and pensioners do not qualify for these loans. In addition, households will typically prioritize investments they better understand, or with perceived higher returns (such as home mortgages or automobiles).

- **Apartment owners (rightly or wrongly) have no incentive to invest in energy efficiency.** Households in Russia typically show little appreciation for energy efficiency measures because they perceive the savings from energy efficiency as being too small to bother. As Section 1.5 indicates, households are not alone. Common spaces in residential buildings, in particular, account for as much as 50 percent of the energy savings potential in residential buildings. Much of that savings could be enjoyed by apartment owners, as simple repairs to doors, windows and hallways in common areas yield substantial savings in heating costs. However, because these common areas belong to the municipality and not to apartment owners, and because very few municipalities have the funds to make the investments, the savings are never realized

In other countries, motives other than financial – such as concern for the environment, for community, or for a neighbor's wellbeing – help drive energy efficiency. In European countries, for instance, individuals invest in energy efficiency largely because of an increased social awareness of and concern for the environment. In the U.S. during the late 1970s, energy efficiency became popular because of individuals' concern with energy scarcity after the oil crisis. In still other cases, energy conservation (such as driving a hybrid car in the US) becomes a status symbol, or political statement. These non-financial motives obviously exist in Russia but have not yet been effectively linked in the population's mind to actions which conserve energy. The population does not see any clear reason to conserve energy.

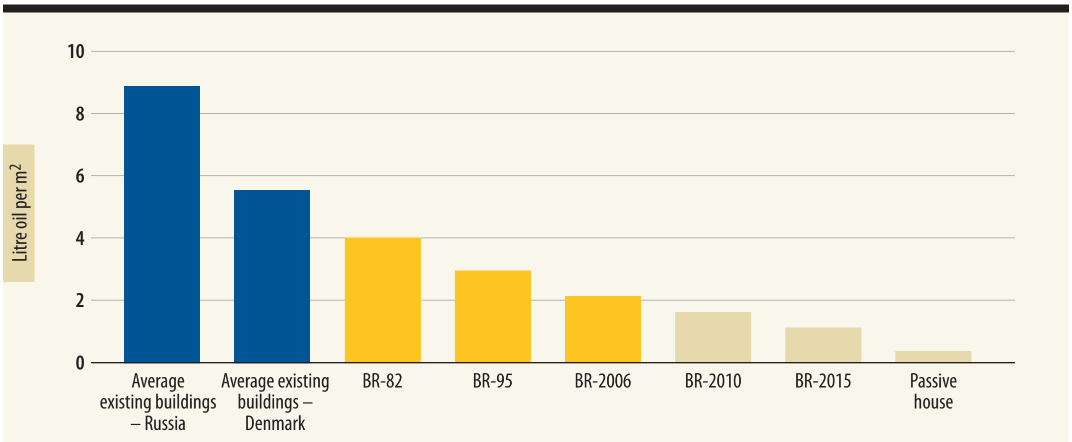
5.3.2 How can energy efficiency in the housing sector be improved?

In order to realize its energy efficiency in residential buildings, the government will need to:

- **Make existing energy efficiency standards mandatory for the construction and renovation of buildings.** Building codes have been a widely used instrument to promote energy efficiency in other countries and are often mandatory. Such standards already exist in Russia, like the Standards on Thermal Performance of Buildings (2003) or the Territorial Construction Norms, which have been adopted in 52 Russian regions including Moscow. However, as previously mentioned, the Standard on Thermal Performance of Buildings is due to become voluntary in 2010. This can put at risk the sustainability of energy efficiency improvements in new buildings. This risk can be addressed by making the C Class ("normal") of Russia's Standard on Thermal Performance of Buildings a mandatory baseline requirement. The required minimum standard level should however be raised over time.

  Mandating energy efficiency in new and renovated buildings is the most cost effective way to ensure energy savings in the residential sector. However, it should not be a one-time legislative policy endeavor. Technologies change with time. What were considered the most energy efficient technologies 15 years ago are no longer the most energy efficient today. In order to achieve and maintain energy savings in the housing sector, standards on the thermal performance of buildings must be periodically reviewed and revised to allow performance criteria to best reflect the most efficient technologies. Figure 50 demonstrates how Denmark building energy performance criteria have been continuously revised since their introduction in 1979. These building performance criteria have become increasingly strict to encourage continued innovation in building energy consumption reduction. These revisions also show how close building regulation will eventually come to passive house criteria.

Figure 50: Denmark's evolving Building Regulations (BRs)



Source: Bach, Peter. *Energy Efficiency in Denmark: What concepts seem to be most promising?* Danish Energy Authority. 28 March 2008 and CENEf.

- **Monitor energy efficiency of buildings in use.** The government can introduce mandatory energy efficiency monitoring and energy passports for buildings in order to ensure compliance with standards and identify potential savings. This would require developing standardized statistical reporting forms and carrying out regular energy assessments of buildings. Energy passports are needed to make energy efficiency a sign of quality for residential housing, as well as to stimulate innovation and efficiency investments. Energy passports can also serve the purpose of raising awareness of both buyers and sellers of houses.

  Such measures have been recently introduced in Germany where it will soon be required that an energy performance certificate, essentially the same as a passport, be made available when selling, renting, or leasing any building built before 1965. By mid-2009, certificates will be required for newer and non-residential buildings along with the requirement that the certificate be publicly displayed in buildings with more than 1,000 square meters of usable area. These certificates have been in effect for new buildings and all buildings undergoing major renovations since 2002. In Germany, the certificates contain three important pieces of information for the consumer: an energy indicator/rating, reference values for the rating, and any renovations that have already been undertaken.[101]

- **Require that energy efficiency improvements be made as a condition of federal or local financial support for capital repairs.** According to the Housing Code of the Russian Federation, capital repairs to residential premises are the responsibility of apartment owners. A number of federal and municipal laws exist (for example, as provided in Federal Law #185 of July 21, 2007 on Fund to Assist Reform of Housing and Communal Services) which provide for financial support to capital investments in existing buildings. The concept of energy efficiency has had limited acknowledgement in Russian legislation, and these laws are no different. Introducing and clearly defining the concept of energy efficiency in federal and municipal funding provisions would ensure that households include energy efficiency investments when making capital repairs. Box 5.6 shows an example of how Japan provides subsidies for capital repairs in residential housing.

Box 5.6: Government subsidies for capital repairs

In Japan subsidies are offered for house renovation to meet thermal insulation standards required by the Energy Conservation Law, the installation of energy efficiency appliances, and efficient renewable energy systems. These apply to both newly constructed and existing houses. To qualify for the subsidies, energy consumption must be reduced by 15 percent for newly constructed houses and by 25 percent for renovated houses, compared to the standard energy consumption without energy efficiency improvement work. Homeowners are also required to report their energy consumption for three years after renovation or construction of houses. Expected savings calculations are submitted to the New Energy and Industrial Technology Development Organization (NEDO), which administers the subsidies. Homeowners are then required to report their actual energy savings by answering NEDO's questionnaires.

Source: "Promoting Energy Efficiency Investments." Case Studies in the Residential Sector. IEA, 2008. 62.

- **Establish a capital repairs loan guarantee facility.** Many countries have created an institution, which provides loan guarantees to owner associations for capital repairs. The task for such a facility would be to:

  – Provide a loan guarantee, which would reduce banks' perception of risk and prompt local banks to begin working with home owners associations in financing energy efficiency-related capital repairs; and

  – Help shift owners' attitudes from being dependent on municipalities for home improvements to taking on the responsibility for their own property.

[101] Jaensch, Volker. "German Energy Certificate for Buildings – Experience with Implementing the EU Building Directive in Germany." DENA. 24 April 2006.

Such facilities have been an especially important source of financing for capital repairs of residential buildings in the countries of Central and Eastern Europe and the Baltics. In Slovakia, for example, guarantees for loans to owner associations, cooperatives, and managing organizations are issued by the only state-owned bank in the country, the State Bank for Guarantees and Development. In Lithuania and Estonia, specialized guarantee agencies were created with support from the state. The agencies provide guarantees to home owners' associations and managing companies for capital repairs and renovation of multi-apartment buildings for up to 75 percent of the loan amount. The fee charged for the guarantee is usually 1.5-2 percent of the guaranteed loan amount. Box 5.7 describes in more detail how loans to HOA-managed buildings were financed in Lithuania.

Subsidies have sometimes also been used to facilitate access to capital for home modernization. For instance, in Slovakia a home owners association can obtain a subsidized loan from the State Fund for Housing Development for improving energy efficiency of a multi-apartment building. The loans can cover up to 80 percent of the cost of renovation project for up to 20 years (with a limited amount per apartment) at a 3.3 percent annual interest rate if the project is included into the Program for Renovation of Housing Stock. Projects that are not part of the Program can obtain loans for 10 to 20 years at a 4.9-6.5 percent annual interest rate. To qualify for the subsidized loans households must achieve at least a 20 percent reduction in energy use compared to their pre-project consumption levels.

Box 5.7: Energy efficiency in Homeowners Association (HOA)-managed residential multifamily buildings in Lithuania

From 1996 to 2001, the Lithuania Energy Efficiency Housing Pilot Project, financed by the World Bank, took on the task of advising Homeowners Associations (HOAs), financing loans, and providing technical assistance and public information in an effort to increase the energy efficiency of multifamily residential buildings in Lithuania.

Financially, the project included various components to assure that participants received market competitive rates while cushioning those participants who wanted to invest, but didn't have the upfront capital resources necessary to do so. Specifically, the project provided:

- Loans in local currency at an 11 percent fixed interest rate, minimum 10 percent down payment, no mortgage requirements for HOAs, and a maximum loan maturity of 10 years
- Since January 1999, matching grants of 30 percent of the loan principal, not exceeding $12.5 per square meter, from the Lithuanian government

The project stipulated that loan proceeds could only be use for energy efficiency investments. Loan repayments were shared between homeowners, typically based on apartment size, according to agreements made in HOA meetings. A portion of existing heat subsidies to low-income households were allowed to be used towards repaying the energy efficiency loans.

Over the course of the project, 726 HOAs were advised on energy efficiency, 331 residential buildings were audited, and 229 energy efficiency projects were implemented. From 1996 to 2001, loans to HOAs totaled $7.2 million with an average loan per building of $31,500 and an average loan per apartment of $1,000.

On average, homeowners registered energy savings of 17 percent per year. Based on a survey, 56 percent of homeowners reported a decrease in their heating bill and 48 percent reported improvement in housing quality.

Source: Taylor, Robert P. et. al. *Financing Energy Efficiency: Lessons from Brazil, China, India, and Beyond.* The World Bank: 2008. 206-109.

- **Develop standardized performance-based management contracts for Homeowners Associations (HOAs) and building management companies.** HOAs or building management companies can help aggregate individual homeowner capital to make building-wide energy efficiency investments, or improvements in common areas. There are currently few functional HOAs in Russia, and the HOAs that do exist often lack the coordination to gain sufficient financial support for investments in common areas, and lack any property to offer banks as collateral. Few building management companies are yet well-established, but this may change as recent legislation requires all buildings to appoint building managers. Their remuneration, moreover, is usually based on a fixed fee which does not provide incentives to promote energy efficiency.

The government can help ensure that HOAs and building managers, as they do take on more important roles in Russia, include energy management as one of their roles. Building managers, whether individuals in an HOA or private firms, can fulfill the functions of an ESCO, for example, by guaranteeing building residents some level of "comfort" (in terms of temperature, and availability of lighting), rather than a specific level of energy consumption, in return for a fixed fee. The government can promote this concept by issuing standardized, "model" building management contracts, which include an energy management component, service quality (or "comfort") indicators, and payment terms which offer the building manager some incentive to take on this role. Since individual meters can be expensive and allocators have not proven to be particularly cost-effective in many countries, simple formulas based on heated area, capacity of radiators, level of window insulation, and availability of thermostatic valves can be developed to allocate heating cost and encourage energy efficiency. Management companies shall also be motivated to invest in energy efficiency of common areas by being able to retain part of the savings.

- **Provide incentives for more widespread metering.** Metering of gas and heating can produce significant savings in residential buildings. Customers can be given incentives to purchase their own meters by raising the normative tariff, so that their bills decrease substantially when consumption is measured and charged on a metered, instead of normative basis. The government may want to consider providing free or subsidized meters to low income customers, through a targeted program. In many cases, customers could already save money by moving to metered connections, without increasing normative tariffs. In Rostov, for example, there are more than 3,200 heat consumers in municipal housing connected to the centralized heating system. Heat meters were installed in 357 houses.[102] Actual heat consumption in the houses equipped with meters is 12-37 percent lower than consumption norms. For hot water, it is 10-33 percent lower than the norms.[103] To help facilitate the success of metering incentive programs, federal, regional, and municipal governments may also want to help disseminate information about the benefits and savings from metering.

Box 5.8: Water metering program in Yerevan, Armenia

In order to overcome the two main inhibitors to widespread metering – the cost of installation and the process of transitioning customers to a new payment scheme – the municipal government of Yerevan enacted a law that provided partial forgiveness of debts to customers who installed water meters. As a result of the program, installation of meters increased from 1,000 in 1999 to 277,000 in 2005. Nearly 80 percent of residential customers are now covered by meters, which includes approximately 90 percent of Yerevan's multi-apartment buildings. As a result of the metering, and the use of volumetric tariffs for water consumption, average daily residential per capita consumption decreased from 250 liters to 110 liters. Overall, consumption in all sectors has decreased from 112 million m^3 in 2002 to 77 million m^3 in 2005, a reduction of nearly 30 percent.

Source: Mugabi, J., P. Marin, and J.Kamkwalala. *Improving Urban Water Services through Delegated Management to a Private Operator: Case study of Yerevan, Armenia.*

102 A. Kovalchuk, *The state of municipal heat supply system and ways to improve it*. Rostov-on-Don 2006.

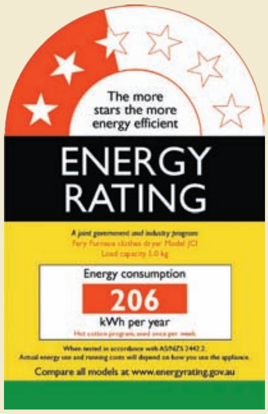
103 This study recommends apartment-level metering for gas and electricity, but not for heating. Apartment-level heat meters and heat allocators are prohibitively expensive (roughly 150,000 Russian rubles, or $6,000). Allocators are, moreover, easy to manipulate.

In addition to meters, which allow customers to monitor and control their consumption, buildings can be designed to more effectively facilitate regulation of heat supply at the individual level. Horizontally designed heating systems or two-pipe vertical heating systems can allow for individual control of heat consumption. However, due to the high costs of redesigning heating systems in existing buildings, application of more efficient heating system designs is only recommended in new buildings or those undergoing substantial renovations. Likewise, such systems must be coupled with individual meters, which provide an economic incentive to proactively control and reduce consumption at the apartment level.

- **Introduce energy efficiency standards and labeling for lighting and household appliances.** Energy efficiency standards and labeling will encourage industries to produce efficient products and help inform consumers about which goods are most efficient. Similar standards have been extensively used with success throughout the world. Roughly 60 percent of European countries have refrigerator standards. In OECD America and Asia over 80 percent of countries have appliance standards. In Europe refrigerator standards coupled with a labeling program increased sales of Class A refrigerators (the most energy efficient class) from 5 percent in 1995 to 23 percent in 2000 and 61 percent in 2005. In addition, studies have shown that increased use of more efficient appliances have not resulted in higher prices for consumers in these countries.[104] Box 5.9 describes Australia's Minimum Efficiency Standards Performance and labeling program.

Box 5.9: Efficiency Standards and Labeling for Household Appliances

Many countries have introduced labeling programs and efficiency standards to promote the use of energy efficient household appliances. Labeling programs provide consumers with information to make purchases with energy efficiency in mind. Efficiency minimum standards improve the energy efficiency of new appliances and remove the least efficient appliances from the market. The two differ in that standards force removal of inefficient and usually inexpensive appliances from the market that labeling would only try to persuade consumers to avoid. In most cases, these two approaches used in conjunction with one another have successfully allowed manufacturers to adapt to the restrictions without raising the cost of the appliances to consumers.



Australia's Minimum Energy Performance Standards (MEPS) and labeling program demonstrates the successful application of standards and labels to household appliances. In Australia, numerous household products have MEPS, meaning that they have a minimum energy efficiency level regulated by the Australian government. Approved energy labels are also mandatory for a number of electrical products including: refrigerators and freezers, clothes washers, clothes dryers, dishwashers, and air conditioners. These labels give the consumer a quick comparative assessment of the product's energy efficiency and show the product's typical energy consumption in a year.

To be successful, these programs must be continually revised and upgraded to encourage improved technology and more efficient products.

Source: www.energyrating.gov.au

- **Consider how best to change behavior.** The manner in which information is presented is a key determinant of whether or not individuals will change their behavior. Raising awareness about energy efficiency by linking it to environmental campaigns has been largely successful in Europe. However, a recent study in California showed that people are more influenced by social norms than information. The study monitored a campaign to get hotel guests to reuse their towels. The information was given to the guests in three

[104] *Energy Efficiency Policies around the World: Review and Evaluation.* World Energy Council 2008. 43-47.

formats. One proposal said that reusing towels was good for the environment. A second proposal focused on cooperation by encouraging guests to partner with the hotel to save the environment. A third proposal – the most successful in getting guests to reuse their towels – suggested that guests should do as their fellow patrons have done and reuse their towels.[105] This brief example has major implications for dissemination campaigns. In creating an energy efficiency information campaign in Russia, policymakers will need to focus on tactics that most effectively engender response and action on the part of individual households. Only when energy efficiency becomes a social norm will everyday consumption practices and energy use values shift in Russia.

- **Launch an information dissemination campaign about energy efficiency.** As noted above in the discussion about behavior, an information dissemination campaign can be an effective tool to inform households about the multiple benefits and ease of investing in energy efficiency. Information dissemination is vital to increasing awareness of and appreciation for energy efficiency. Such a campaign might include information about: capital repairs, including financing opportunities, usage of apartment insulation materials, or the benefits from using more efficient lighting. Box 5.10 describes an innovative information and dissemination campaign run by a not-for-profit organization in the UK.

Box 5.10: Kirklees Energy Services: An Information Service Provider

In the U.K., several energy savings organizations jointly created Kirklees Energy Services, a not-for-profit company designed to provide free and impartial energy advice to domestic households. The service is considered a "one-stop shop" for energy efficiency information and advice accessed via a free phone number. Specifically, the program:

- Advises homeowners on energy efficiency measures by referring them to an approved installer who inspects their property and recommends appropriate energy efficiency work,
- Provides a cash back payment to the household to reimburse the owner for the cost of the inspection,
- Offers installation of energy efficiency measures (i.e. cavity wall insulation, loft insulation, draught-proofing of doors and windows, heating controls, hot-water tank insulation, floor insulation and condensing boilers) at discount prices due to network with installers set up by KES,
- Provides information on preferential loan schemes and financial institutions willing to fund energy efficiency investments.

Source: *PPPs for Energy.* Danish Energy Authority. 28 March 2008.

5.4 What are the barriers and solutions to improving energy efficiency in Russia's public buildings?

In contrast with the other sectors discussed in this chapter, the government can directly remove barriers to energy efficiency in Russia's public organizations, and can directly receive the benefits of removing these barriers. Public organizations (POs) are under the control of federal or local governments, and activities to improve their energy efficiency can be implemented through existing administrative measures. Moreover, improving energy efficiency frees up fiscal resources, particularly for constrained regional and municipal budgets, that can be redirected to meeting other needs.

Supporting energy efficiency measures in POs is the fastest and easiest way that Russia can send a strong signal to the private sector and the public about the government's commitment to energy efficiency. Since POs fall directly under the government's control, they do not experience common motivational barriers, like the split-incentive problem, that hamper energy efficiency improvements

105 Cialdini, Robert B. "Using Social Norms to Preserve the Environment." Arizona State University, Department of Psychology.

in other sectors. As such, if the Russian government is dedicated to promoting energy efficiency, it should not delay in introducing obligatory EE standards and other incentives to promote the energy efficiency of public buildings.

The most significant barriers to energy efficiency in Russia's public organizations relate to the laws and rules for procurement, budgeting, and transferring funds to those institutions. Key solutions include changing the budgeting rules and better enforcing existing standards. Figure 51 shows the principal barriers and prioritized solutions to energy efficiency in public buildings. We discuss these barriers in detail in Section 5.4.1 and Section 5.4.2.

Figure 51: Barriers and Solutions to Energy Efficiency in Public Organizations

Barriers	Solutions	
▪ Public organizations cannot retain any energy cost savings ▪ Public organizations cannot enter into financing agreements, multi-year contracts, or contracts that pay for the investment through future savings ▪ Procurement rules favor lowest cost of bid, not the lowest *lifetime* cost ▪ Very little statistical information or awareness exists	Quick Wins	▪ Allow more budget flexibility ▪ Change procurement legislation to allow for multi-year contracts ▪ Prioritize EE equipment procurement
	Essentials	▪ Set energy consumption targets based on benchmarking ▪ Introduce autonomous status of public organizations ▪ Disseminate information on energy efficiency

5.4.1 What is hindering energy efficiency in public organizations?

The principal barriers to energy efficiency in public organizations are the following:

- **Budgeting rules tend to give public organizations more incentives to use energy to excess, than to save it.** The current method of budgeting for public organizations' communal expenses does not consider actual energy needs. Public organizations generally do not participate in local government budgeting processes. Instead, allocations for public organizations' communal expenditures are determined by the Municipality, and driven largely by previous years' consumption or a statistical average for public organizations of a similar type. Yet public organizations that serve one and the same social purpose may differ radically by their time in service, level of depreciation of equipment, characteristics of their building, and type of energy consumption.

  Under current budgeting rules, public organizations are not allowed to retain or reallocate any savings on communal expenses. For example, if a public organization within a municipality consumes below its limits, the municipal government will likely cut that organization's limits for subsequent years. Public organizations therefore often consume just beyond their budget to ensure that they will not lose funding in the future. The same set of perverse incentives applies to regional and municipal governments themselves. If municipalities consistently fail to spend their budgets, they run the risk of having the regional government reduce allocations for years to come.

- **Public organizations cannot enter into financing agreements, multi-year contracts, or contracts that pay for the investment through future savings.** Energy efficiency investments require medium- to long-term financing, but public organizations, by law, cannot enter into any sort of financing arrangement with third parties, nor could they (until recently) enter into contracts for periods longer than a year.[106] Procurement legislation, moreover, does not allow public organizations to fund investments by sharing future savings on operating costs, nor does it consider life-cycle cost concepts. These restrictions collectively stifle the evolution of organizations like ESCOs, or companies providing ESCO-like functions, which could help public organizations save on energy consumption.
- **Energy-related standards are not enforced.** Where energy-related sanitary and comfort standards do exist for public buildings, they are often not enforced. Because lighting systems in many Russian schools are 40-50 years old, lighting often falls well below the standard. Temperature levels may be either too high or too low, depending on the time of year and the building in question. In some of the regions of Far East of Russia, low temperatures in Public Organizations during winters still represent a serious problem. Paying for energy resources, which are often supplied in excess, public organizations do not receive the proper level of comfort. As a result, there is evidence of schoolchildren developing eyesight problems, and high rates of illness due to under- and over-heating.[107]
- **Very little statistical information or awareness exists.** As is the case in other sectors, there is a dearth of information on energy consumption by public organizations, and how that consumption might be reduced. No system for gathering and processing data on public organizations' energy consumption exists at any level of government. Public Organizations themselves are generally unaware of whether they need to improve energy efficiency, and what can be done to improve energy efficiency (which includes not just reducing energy consumption, but achieving more satisfactory levels of output, for example, better lighting and heating). For all of the reasons described above, they rarely adopt modern energy management techniques, and show a great deal of conservatism in their choice of equipment, technologies and service personnel *("zavhozes").*

5.4.2 How can energy efficiency in public organizations be improved?

Despite the ease of intervening to improve energy efficiency in public sector buildings, and its advantages, little has yet been done in Russia. There have been only a few attempts in selected regions (described in Box 5.11). These efforts have been largely related to introducing metering which, while important, is limited in its effectiveness if other crucial energy efficiency improvements have not been made. Metering can only achieve so much if, for example, tariffs remain below cost recovery levels, or utility billing practices do not change. In a number of cases in which metering has been introduced in public buildings, actual billing and payments are continued on the basis of norms rather than actual consumption due to lack of management organizations' awareness, incentives or, in some cases, technological complications.

[106] Until recently, the budget code of the Russian Federation did not allow public organizations to enter into contracts for periods longer than a year. Since 2007, mid-term (three year) budgeting is being gradually introduced, but a three-year term remains too short to see payback from many energy efficiency investments.

[107] CENEf , *Assistance to energy efficiency and energy resources saving in budget and communal sphere.*

Box 5.11: Efforts to Improve Metering in Russia's Regions

Many regions in Russia have recognized the need to install meters in order to take better stock of their fuel, energy, and water consumption. Installation of meters is an initial, crucial step towards realizing other energy efficiency measures, as it makes clear to consumers the relationship between their energy consumption and its cost.

These measures have been shown to help oblasts save considerably on utility expenses. For example:

- Chelyabinskaya oblast has installed more than 1,600 heat, electricity, and water meters in its public buildings. The meters allowed the oblast to save 170 million Russian rubles in communal expenses between 1997-2005, which constitutes around 3 percent of the oblast's expenses on communal services in 2005.
- In 2001-2002 Rostovskaya oblast spent 52 million Russian rubles from the public budget to install 893 heat meters, 355 water meters, 30 gas meters, and 65 electricity meters in public buildings. Average monthly savings resulting from these investments reached 20-40 percent. Total energy consumption by public institutions dropped, on average, by 10.7 percent between 2001 and 2002. More specifically, energy consumption dropped 30.5 percent in educational institutions, 13 percent in cultural institutions, and 5 percent in hospitals and healthcare facilities. The pay-back period after installation of these meters averaged 2-4 years
- In Petropavlovsk-Kamchatsky, 100 heat meters were installed in 2006-2007 in city schools and kindergartens. The meters resulted in savings in utility expenses by 19 percent in 2007 and 13 percent during the heating season of 2006-2007.

Source: CENEf – regional benchmarking for World Bank Group.

In addition to increasing metering, the government can give public organizations a number of powerful incentives to improve energy efficiency. The government can help public organizations by:

- **Allowing more flexibility in budgeting.** Public organizations need more flexibility to retain some of their savings on energy consumption. The government can allow the savings to be shifted to other categories of expenditure, rather than simply saved for future energy consumption. With greater flexibility, public organizations could transfer the savings to other energy-related expenditures (for example, capital expenditure which will yield further energy savings), or may wish to allow the transfer of surplus funds to other categories of expenditure (for example, learning materials for schools, or pharmaceuticals for clinics).

  Ultimately, Russia could provide the greatest incentive for public organizations to improve their energy efficiency if it transferred budget funding as block grants, without any earmarking for any particular expenditure. Such budgeting is legally possible in Russia but is rarely used because public organizations are typically perceived as passive spenders of budget funds, and incapable of proper financial management. Some forms of block grants (normative per capita financing – a term used in Russia) are being introduced in Russia in a number of pilot regions, such as Chuvash Republic, Samarskaya Oblast, and Yakutia; but to a great extend the approach applies only to core expenditures, such as, in the case of schools, textbooks and teachers' salaries, financed from the regional budget, with communal expenses remaining uncovered by the new system

- **Giving public organizations autonomous status.** Russia could give public organizations a further boost toward financial autonomy by granting some organizations the status of autonomous organization. As with lump sum grants, budget funds are allocated to an autonomous organization without any specific provisions as to how to use them. The status of autonomous organization gives the public organization the additional ability to optimize not only budget-financed spending, but also off-budget money that they manage to earn themselves. Autonomous organizations will of course require an additional level of oversight (a Board of Directors or Trustees), as the government retains its ownership but has given the public organization the purview to operate more like a commercial entity.

The Law on Autonomous Organizations was adopted in 2006. Since then 15 regions of Russia have introduced corresponding changes to their legislation and some of them have piloted the schemes, such as Tymenskaya, Krasnoyarskaya oblast, Tatarstan and other regions. Yet there is big resistance in many municipalities to the scheme because they fear losing control over funding.

- **Benchmarking.** In order for the above recommendations to work, regional, federal and municipal governments will need to set a baseline level of expenditure on energy consumption, as well as targets or benchmarks against which a public organization's progress in reducing energy consumption can be judged. The baseline can be fixed based on the public organization's energy expenditure in the most recent year, or an average of recent years. Targets or benchmarks can be set based on comparisons with other public organizations with similar characteristics, such as the area occupied by a public organization, load characteristics, mix of fuels consumed, and number of individuals served (for example, in a school, the average number of pupils attending classes each year). The results of the benchmarking need to be made easily available to all public organizations, as should possible energy efficiency solutions, best practices, and success stories from other sectors in Russia and from comparable public organizations abroad. Such benchmarking will require that the government put in place some sort of standardized monitoring of data on communal expenses and energy consumption. No such data currently exist, but are essential for planning, designing, and implementing energy efficiency programs.
- **Setting targets.** Setting target indicators (consumption allowances/limits) may be an effective tool especially since it is already quite a common approach in Russia. In Chelyabinskaya oblast, a twofold decrease in energy consumption has been achieved in 1999-2004 thanks to revising the limits. The approach has also proven to work well elsewhere. In the United States, the government has set a target to reduce energy consumption in public buildings by 3 percent annually during 2006-2015. The previous target of 2 percent was successfully met.[108]
- **Change procurement legislation to allow for multi-year contracts.** In order to reap the benefit of energy efficiency investments, public organizations need to be able to enter into multi-year contracts. Budgeting principles, similarly, must be based on full life-cycle costing in order to capture the energy efficiency benefits of particular investments. The United States and Canada revised similarly rigid procurement rules, by revising their procurement legislation. In doing so, they helped drive the market for energy efficiency equipment, and help encourage the development of providers of companies with ESCO-type functions. Allowing entities with ESCO-like functions to enter the market can solve the problem of public organizations not being able to borrow. ESCOs or firms with ESCO-like functions, can enter into financing arrangements with the banks, and take the risk on the loan, while providing energy management services (under so-called Energy Performance Contracts, or EPCs) to public organizations for a fixed fee. Box 5.12 discusses the measures taken in the United States and Canada to promote ESCOS.

[108] "US Federal Government: Energy Efficiency and Market Leader". Jeffrey Harris. Alliance to Save Energy. Energy Efficiency Initiatives in the Public Sector, World Bank, BBL, June 2007.

Box 5.12: Evolution of ESCOs in the United States and Canada

In the United States and Canada, the success of ESCOs and EPCs to promote energy efficiency in public buildings relied heavily upon the successful navigation of public sector contracting requirements and extensive procurement processes. The two countries utilized different approaches to increase the development of EPC-based projects in public buildings.

In the United States, where legislation and legislation enactment procedures differ from one level of government to the next, contracting and procurement requirements and barriers were overcome on a state-by-state and agency-by-agency basis. However, once one state had a functioning contracting and procurement system in place to promote EPCs and ESCOs, other states were more willing to adapt those models to their own circumstances. For example, Ohio, in 1985, enacted legislation allowing school districts to purchase energy conservation measures on a multi-year installment basis and to increase the portion of a district's net indebtedness that could be used for energy conservation measures. In the first five years alone, the legislation led to ESCO projects in 167 school districts worth more than $131 million. Now, over 40 US states have enacted legislation promoting the usage of EPC in schools and government facilities.

At the federal level, the Comprehensive Omnibus Budget Reconciliation Act of 1985 encouraged federal agencies to implement energy efficiency retrofits through shared energy savings contracts. Subsequent legislation provided further incentives by allowing participating agencies to retain and use a portion of their foregone energy costs. When government agencies realized that energy savings could be reinvested in other areas of their programs, it provided a powerful incentive for staff members to work with ESCOs in identifying projects. The Federal Energy Management Program (FEMP), operated by the Department of Energy, coordinates federal agencies' energy efficiency projects. FEMP maintains a list of approved ESCOs and has developed the Super ESPCs, which allows federal agencies to "bypass procurement procedures and deal directly with prequalified" ESCOs, who compete to win the contracts. By 2007, the Super ESPC concept had investments of $1.9 billion by 19 agencies in 46 states.

In Canada, the development of EPCs and ESCOs for use with public buildings was implemented from the top down. Canada's involvement with EPCs for public buildings began with Ontario Hydro's Guaranteed Energy Performance Program in the late 1980s and received a boost in 1991, when the Canadian government created the Federal Buildings Initiative (FBI) to allow federal departments to contract with ESCOs to develop and implement energy efficiency retrofits through EPC in federal buildings. Natural Resources Canada (NRCan) promotes the FBI program to individual organizations by providing model contracts and bid packages. The FBI has retrofitted 7,500 federal buildings and other facilities, have resulted in 240 milllion Canadian dollars of private sector investment (through 2006) and annual savings of $33 million Canadian dollars.

Source: *ESCO Development in the United States and Canada.* R. Taylor (2008). pp 224-238

- **Enforce energy efficiency in equipment procurement.** The government may wish to impose technical standards related to, for example, procurement of energy efficient equipment for heating and lighting, or energy efficiency standards for rehabilitation and expansion of capital. Such standards are easier to impose on the public sector than private sector institutions or the population. The government, in its role as owner of these organizations, faces fewer obstacles to setting new standards, and has a relatively easier time monitoring and enforcing the standards since it may do so through existing, internal governance rather than – potentially difficult and expensive – external monitoring. Box 5.13 shows how China has taken the initiative to heavily endorse energy efficient lighting in its provinces. Moreover, public organizations, because they are not profit oriented, generally have less to lose than private companies (or, more intuitively, less to gain from flouting) standards.

Box 5.13: Energy saving light bulb targets in China

China recently announced that it will require provincial governments to replace 50 million traditional incandescent lamps with heavily-subsidized energy-efficient lights this year. As part of a campaign launched by the Ministry of Finance in January, the goal is to replace inefficient bulbs with 150 million energy efficient light bulbs over the next 5 years. Several provinces received specific targets of 2 or 3 million bulbs, including a 2-million bulb target for Beijing. If all incandescent bulbs were replaced, China would save 60 billion kilowatt hours of power each year, or 22 million tons of coal equivalent each year, reducing emission of carbon dioxide by 60 million tons.

Source: "China sets energy-saving lightbulb target for provincial areas." Xinhua News Agency. 14 May 2008.

5.5 What are the barriers and solutions to energy efficiency in industry?

As Chapter 4 showed, industry has the second biggest potential for energy savings. Energy efficiency potential exists for large, as well as small and medium enterprises. The potential of the top five energy intensive sectors (41 percent of potential in industry) is almost equal to the potential of less intensive industries (42 percent of potential in industry). Therefore, energy efficiency policy should not be limited to one segment of the sector, but instead should address needs and barriers throughout the industrial sector.

Figure 52 summarizes key barriers preventing energy efficiency in industry as well as prioritized government solutions. The most significant barriers are related to industrial managers' lack of awareness about, and incentives to pursue energy efficiency, the availability of affordable financing, and the fact that tariffs consistently lag inflation. The government should first focus on solutions that combine a comprehensive awareness campaign with measures allowing easier access to capital through local financial institutions. Additional fiscal incentives and continuation of energy sector reforms can be next step measures to help stimulate investment in energy efficiency.

Figure 52: Barriers and Solutions to Energy Efficiency in Industry

Barriers	Solutions	
■ A lack of awareness among managers ■ Macroeconomic constraints on banks ■ A failure of banks to understand energy efficiency investments ■ High transaction costs ■ Tariffs that lag producer prices ■ Inflexible electricity and gas supply contracts	Quick Wins	■ Disseminate information on energy efficiency
	Essentials	■ Facilitate financing for EE investments through Russian financial institutions ■ Develop equipment standards and labels ■ Provide subsidies for transaction support ■ Provide fiscal incentives ■ Introduce taxation or 'cap-and-trade' schemes for pollutants and/or emission
	High Cost, High Return	■ Complete electricity sector reforms, and initiate gas sector reforms

5.5.1 What is hindering energy efficiency investments in the industrial sector?

Great potential exists for energy savings in the industrial sector in Russia, but companies have yet to realize this potential. Industry is not realizing its full energy potential in Russia because:

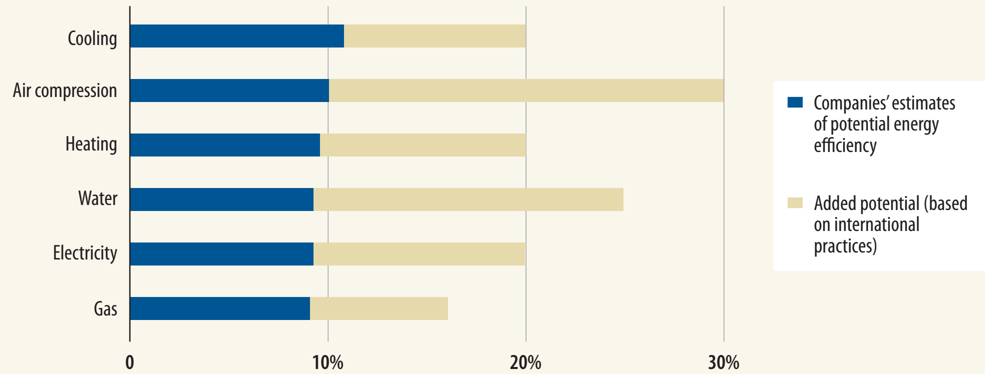
- **A lack of awareness among managers.** Most managers are not fully aware of their companies' energy efficiency potential, what investments might be required to reach that potential, and how to finance those investments. The bullets below discuss each of these barriers.
  - Managers of many Russian industrial companies are not fully aware of the energy efficiency potential their companies have. Managers tend to be overly conservative when assessing energy savings potentials. They believe they may only be able to save 8-10 percent, when in fact they could reduce their energy consumption by 20-30 percent. This phenomenon is demonstrated in Figure 53 below. Managers' lack of awareness about energy efficiency is due both to a lack of equipment metering the use of energy at the production level, and to a lack of adequate access to information.

The majority of enterprises in less intensive industries lack the ability to measure their energy consumption. Only 40 percent of SMEs monitor their energy consumption at the workshop level, and only one out of ten companies has an automated energy cost control system. Others only have the energy cost data of the entire company. Without accessible and reliable data demonstrating energy consumption, companies are unable to see their cost reduction potential and will have more difficulty determining which production units possess the greatest potential for energy savings.

Heavy energy consumers report specific energy consumption to the Federal Statistical Office, but this information is not shared publicly. Best practice guides and benchmarks from international experience, which have been developed in a number of countries, are not available in the Russian language.

Figure 53: Russian enterprise managers underestimate EE potential of their companies

By what percentage can a company reduce consumption of the energy resources listed below while maintaining current production levels?

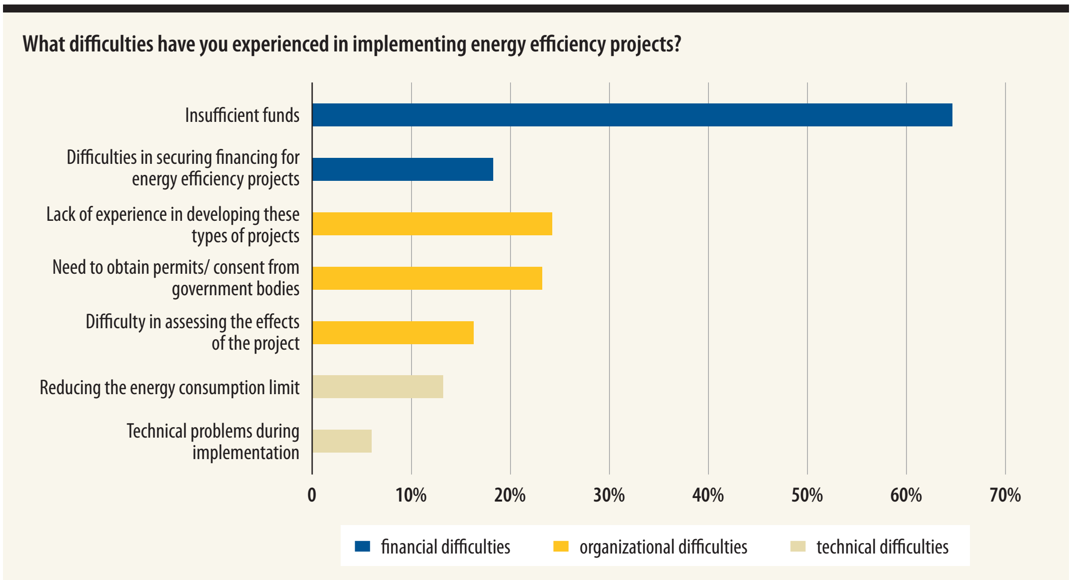


Source: IFC.

– Managers have limited awareness of how to improve energy efficiency. Companies often do not know well what measures exist to save energy at their facilities. Part of the problem may be due to the fact that traditional methods of spreading information about the benefits of energy efficiency have limited outreach to the target audience. Dissemination of information through energy saving exhibitions, which are carried out almost in every region, does not always reach decision-makers in industrial companies, especially SMEs. And, industrial customers are, in particular, generally averse to using a new technology which they may view as untested and potentially more expensive.

– Managers do not know what opportunities exist for financing projects. Even when end-users can measure the amount of energy savings potential, they may not have easy access to information on how to finance the investments required to achieve this savings. Most energy efficiency projects carried out by industrial companies have a pay-back period of two to six years and therefore can be financed with currently available bank loans. Nevertheless, nearly two-thirds of enterprises consider their lack of existing financial resources to be the main barrier to carrying out energy efficiency-related projects. Figure 54 shows this result from an IFC survey. Moreover, only one out of every four companies citing insufficient funds actually sought outside financing, even though 90 percent of the companies that sought external financing received it.

Figure 54: Barriers to implementing EE projects in industrial companies



Source: IFC.

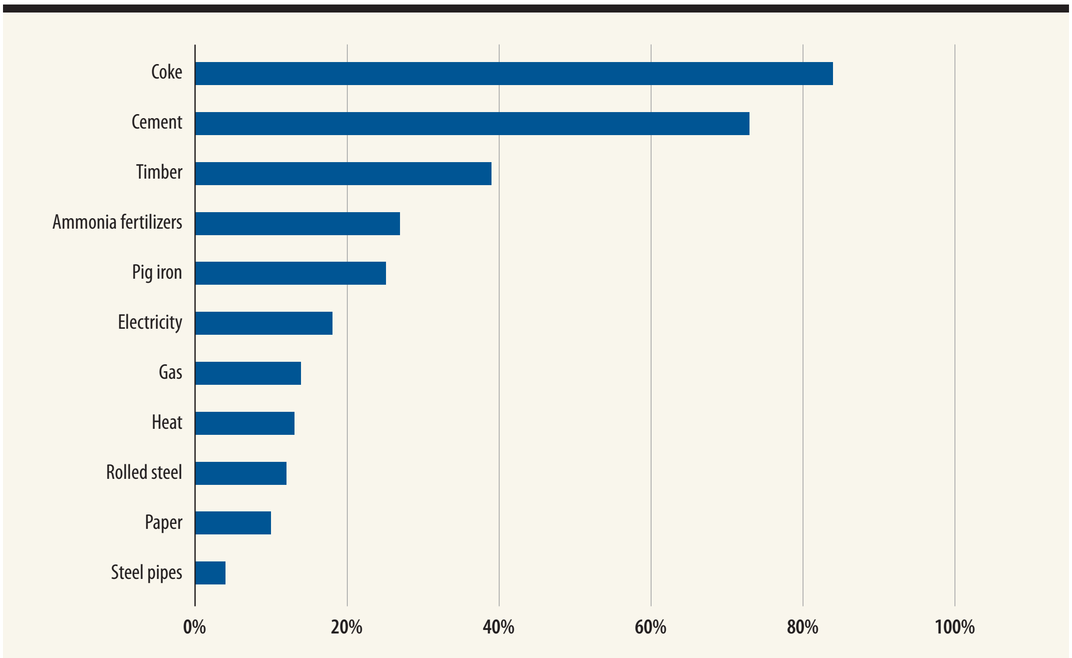
- **No incentives for managers to adopt energy efficiency measures.** Enterprises are often not motivated to undertake energy efficiency measures, even if those measures have proven to be successful elsewhere. Measures like energy efficient lighting and installation of variable control drives are still not very popular in Russia. Many companies do not want to lead the way in adopting a new product, technology or business culture. The corporate environment within a company can also deter energy efficiency. Many individuals within a company are hesitant to suggest energy efficient alternatives without the support of company leadership. Moreover, companies do not fully utilize efficient organizational structures, giving managers no motivation to endorse new ideas and new practices, like energy efficiency.
- **High transaction costs, especially for SMEs.** Transaction costs are incurred during the identification, design and savings appraisal of energy efficiency projects. Companies, especially SMEs, often lack the capacity to carry out sufficient, in-depth analysis and develop a tailored approach that is necessary to determine how they can cut energy costs. As such, the benefits from energy savings are often considered insignificant compared to the transaction costs of customized project development. In addition, companies often think of financial gains in terms of projects that expand production, launch new products or capture new markets, especially in rapidly growing economies. This assessment of costs and benefits further inflates companies' perception of the transaction costs of energy efficiency projects.
- **Macroeconomic constraints on banks.** Banks cannot offer attractive financing terms for industrial modernization projects (which include energy efficiency investments) because banks themselves have limited access to medium and long term funding. Banks' shares of long-term (more than three years) deposits is as low as 5 percent, and their shares of long-term credits (not counting Sberbank) does not exceed 15 percent. The subprime crisis in the US has, in particular, reduced the availability of international funding for local financial institutions. The high cost of capital therefore prevents banks from offering lower interest rates. In the first quarter of 2008, interest rates for medium to large companies were as high as 12-15 percent, and rates for smaller companies now frequently exceed 18 percent.

Due to these constraints of financial markets, few companies are willing to risk investing in energy efficiency for longer than two-three years. High interest rates remain a major obstacle for many enterprises. More than 40 percent of small and medium companies state that the high interest rate of bank loans is the main reason why they refuse to take advantage of external financing opportunities.

- **A failure of banks to understand energy efficiency investments.** Few banks recognize energy efficiency lending as a mainstream market and lack the knowledge and tools to properly evaluate energy efficiency investments in industry. Financiers often lack basic knowledge about energy efficiency investments and don't have the tools (for example, standardized evaluation criteria) that would allow them to lower their transaction costs. Currently fewer than 10 banks and leasing companies (out of more than 1,000) pursue any energy efficiency lending opportunities.

- **Tariffs that lag producer prices.** Companies lack incentive to save because energy tariffs are growing slower than product prices. As presented in Figure 55, in 2007, prices on energy resources increased by 13-18 percent, while in many sectors product prices increased by more than 25 percent. Consequently, the share of energy in the cost of goods was diminished and became less important for enterprises in a number of sectors.

Figure 55: Price indices (December 07 to December 06), %



Source: Rosstat.

- **Inflexible electricity and gas supply contracts.** Municipal gas and electricity suppliers in Russia effectively pre-pay for gas or electricity. The contract requires that total contract payments are based on forecasted demand rather than actual consumption. These "take or pay" contracts have advantages for both long-term capital investments and supply certainty. However, they can also result in severe inefficiencies and overuse of energy if contract limits do not adequately reflect actual demand, and purchasers have no ability to resell their gas or power. Some Russian companies can spend as much as one-and-a-half years securing contract limits. Moreover, due to gas deficits, securing sufficient contract limits is extremely competitive. A company that is unable to use all of the electricity or gas specified in its contract will receive a reduced supply limit for the following year, while still having to pay a delivery fee for the unconsumed resource. As such, many companies are more concerned with retaining their limits than saving electricity or gas. This practice greatly discourages efficient behavior and sometimes even forces companies into having idly functioning equipment in order to reach the limits. 13 percent of enterprises consider this a barrier to their willingness to reduce their energy consumption.

5.5.2 What can the Russian government do to help industry invest in energy efficiency?

While many lessons learned from international practice can be applied in Russia, there are some measures that will clearly not work. In particular, voluntary agreements and requirements that companies meet some specific level of energy intensity have worked well elsewhere but are likely to fail in Russia. Russian industry lacks the culture of business responsibility found in other countries and essential to the success of voluntary agreements. Moreover, no culture of trust exists within industry or between government and industry. Without these elements, voluntary agreements are likely to be of limited use. Mandatory standards, tied to penalties for non-compliance, are also unlikely to succeed. Mandatory standards for specific energy consumption, or mandatory energy audits with mandatory energy passports in industry, will be viewed by businesses as yet another interference in business activities and another opportunity for rent seeking by government officials. Meanwhile, monitoring compliance would prove difficult.

Given the existing barriers in Russia, certain measures will more effectively promote industrial energy efficiency than voluntary agreements or mandatory standards. The barriers described above can best be addressed by:

- **Better dissemination of information on energy efficiency.** The Russian government can create a program, or help to implement a private sector operation that broadly and effectively disseminates information about energy efficiency. A program specifically designed to disseminate information will help Russian companies realize their energy savings potential. Dissemination campaigns make information about energy efficiency investments more readily accessible and useful to industrial companies. Important information to include in this program might include: benchmarking data to allow for sector-wide comparisons of specific energy consumption, best practices evaluation to allow companies to recognize their energy savings potential, model action plans and industrial equipment energy efficiency labeling information (if available) to show companies how they can best invest in energy efficiency, and proven financial opportunities for energy efficient investments to show companies that they can acquire outside financing for EE projects.

  Such a program would be responsible for gathering and organizing sector-wide information on energy consumption, disseminating results and analysis via various media, and potentially providing follow-up advice and services for companies interested in pursuing energy efficiency investments. Potential formats for information dissemination include: websites, benchmarking databases, best practice brochures, best equipment brochure/guidebook, individual consultations, and an advice helpline. Box 5.14 demonstrates how the U.K. initiated a program to disperse information about energy savings and carbon reduction investments.

Box 5.14: United Kingdom Energy Efficiency Best Practice Program (EEBPP)

The United Kingdom EEBPP was designed to promote sustainable energy practices in UK companies through sector-wide information dissemination, implementation advice, and technical assistance. The EEBPP expected to cut the energy bills of UK companies by 10-20 percent and help contribute to the government's compliance with the EU initiative to reduce greenhouse gas emissions by 12.5 percent below 1990 levels by 2008-2012. The program provided information on management and technologies with the intent of serving any public and private sector company for whom the program was deemed cost-effective.

Initially, the program focused on compiling data that would provide information and assistance to companies with high energy savings potentials. The data provided all levels of decision-makers with information about:

- Benchmarking: Comparison, on the basis of anonymity, with sector wide norms in energy efficiency.
- Good Practice Guides and Case Studies: Examples of currently established techniques and technologies with further potential.
- New Practice Case Studies: Recently developed technologies and techniques.
- Future Practice: Collaborative research and development.

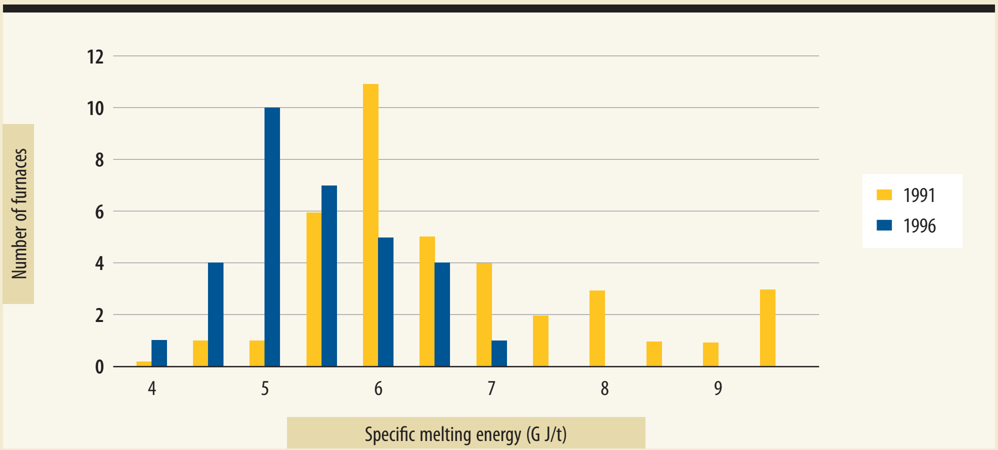
EEBPP later focused on maintaining the information database and promoting companies' adoption of best practices through publications, workshops, and seminars encouraging action and providing support and advice at every stage of the program. Additionally, the program offered information and advice through an Environment and Energy Helpline, a free service to businesses in the United Kingdom. The program also provided a service called "Action Energy" in which companies receive a free visit by an energy consultant who assesses their potential for energy savings, prepares an action plan to reduce unnecessary usage, and follows up to assist in implementation.

The program, which was later subsumed under the UK's Carbon Trust, resulted in verified energy cost savings of £650 million ($1 billion/year) and has saved 3.5 million tons of carbon emissions per year. The EEBPP was successful largely because:

- Information was provided in audience-appropriate formats,
- Anonymity and confidence in commercial security was guaranteed,
- Feedback, progress reporting, and target assessments guided the program's management,
- Industry representatives and trade bodies were consulted in order to provide accessible and usable information.

The figure below shows specific melting energy at glass furnaces before and after participation in the United Kingdom EEBPP.

Glass Furnace – Melting Energy



Source: Shock, Richard. *UK Energy Efficiency Best Practice Program.*

- **Simple project designs and packaged solutions.** Simple project designs can help minimize transaction costs and reduce risks. This can prove easy as, for many of the technologies well proven in the market (such as efficient boilers, building energy management systems, efficient lighting systems, and capacitors), project design is relatively simple and the end users and financiers are reasonably well aware of the risks. Even for certain industry-specific technologies and applications, such as waste heat recovery boilers or natural gas cooling systems with cogeneration, it is relatively easy to follow a template in the replication of design and appraisal of new projects. Sometimes, equipment vendors offer template-oriented energy efficiency project schemes that can be customized to fit the end user needs.[109]

  Employing a so-called "packaging agent" can also help keep transaction costs reasonable. Packaging agents are companies with technical expertise and up-to-date knowledge about possible projects in various areas of energy efficiency. By maximizing their project portfolio, these companies can replicate similar projects and, thus, keep their transaction costs down. Such functions can be performed by an ESCO, DSM specialist firm, or another entity well-suited to accumulate information, knowledge, and project development capacity. Programs that provide such informational, logistical, and assessment support are often run by organizations with public funding. In addition, the government can aid in reducing transaction costs for industry by providing partial or full-cost subsidies for energy audits or disseminating relevant information, as described above.

- **Facilitation of financing for energy efficiency investments through Russian financial institutions.** The Russian government can play a more active role in ensuring access to long term capital through development institutions. Development banks can allocate long-term credit lines dedicated to energy efficiency investments to Russian financial institutions. This model has been tested in a number of countries, including Russia, by IFC and the EBRD, and has proven to be successful. The Russian Development Bank currently provides credit lines to local financial institutions aimed at SME development. This practice can be expanded to include dedicated funding for energy efficiency investments. Box 5.15 shows how dedicated funding helped encourage energy efficiency in Hungary.

Box 5.15: Hungary's Energy Efficiency Guarantee Fund

Begun in 1997, the Hungary Energy Efficiency Co-Financing Program is an IFC and GEF financed loan guarantee program in partnership with local financial institutions. The program offers a partial risk guarantee to financial institutions that provide loans for energy efficient investments as well as technical assistance for both the lenders and project developers. These elements reduce the risk of financing energy efficient investment while also reducing the transaction costs of projects by providing necessary technical knowledge to both parties. By the end of 2006, the $55 million loan portfolio supported with $17 million of guarantees fostered $93 million worth of energy efficiency investments.

Source: Taylor, Robert et. al. *Financing Energy Efficiency, Lessons from Brazil, China, India and Beyond.* World Bank. 2008.

- **Development of energy performance standards and labels for industrial equipment.** The development of energy performance standards and labels for industrial equipment will help companies know how to most effectively invest and will promote the use of more efficient equipment.

[109] Taylor, Robert P., et al. *Financing Energy Efficiency, Lessons from Brazil, China, India and Beyond.* World Bank. 2008.

In other countries, one of the most cost-effective methods for increasing energy efficiency at industrial companies has been to establish energy efficiency standards for industrial motors, power pumps, compressors, fans, and other generic machinery. Currently energy performance standards for motors have been adopted in over 30 countries.

It is essential to make a clear distinction between energy efficiency standard for equipment and a standard or a norm for specific energy consumption. Equipment standards have proved to be an effective instrument in promoting energy efficiency in many countries and can be valuable in the Russian context.

On the contrary, mandatory standard for specific energy consumption is likely to be a complicated measure with limited effect. Due to objective factors, specific energy consumption can vary significantly even for generic products. Many enterprises produce multiple products using the same equipment, and will not be able to attribute the consumed energy across variety of products. In addition, energy consumption standard will not give an incentive to improve beyond the established norm.

- **Continuation of electricity sector reforms, and initiation of gas sector reforms.** Electricity sector reforms in Russia are aimed at improving the efficiency of electricity markets by increasing competition in the sector. More efficient markets mean more efficient resource use, and hence greater energy efficiency. With competition greater product differentiation, and more liquidity in energy markets. Supply contracts will eventually become more flexible than the take-or-pay model currently used in Russia. An increased number of participants will bring more liquidity, and therefore more opportunities to buy energy in the event of an energy shortfall in their contract and sell energy in the event of a surplus. Reforms in the gas sector which mirror reforms in the electricity sector would have similar benefits for improving the efficiency of the gas supply sector.
- **Fiscal incentives.** Fiscal incentives in the form of tax relief can be an effective long-term measure to increase the attractiveness of energy efficiency investments. It is important to emphasize, however, the difficulties and risks of implementing tax incentives in a country like Russia where tax collections remain relatively low, and tax evasion and fraud remain problematic. There are three main forms of providing tax relief for purchase of energy efficient equipment:
  - *Accelerated depreciation* improves companies' cash flows by allowing for a faster write off of the cost of equipment against their taxable profit.
  - *Tax rebates* allow investors to deduct a part of the equipment costs from profits.
  - *Tax exemptions* typically reduce or eliminate custom taxes on energy efficient equipment.

  The tax relief approach has frequently been criticized for three reasons. First, it doesn't stimulate small investments that can be the most cost-effective energy savings measures. Second, it doesn't encourage changes in energy consumption behavior that can lead to substantial energy savings. As a result, additional government intervention is required to stimulate these "no cost-low cost" measures. Third, a substantial number of investors might have implemented the project anyway without any subsidy. For example, evaluation of the Dutch Energy Investment Deduction program concluded that 45 percent of surveyed participants would have made a purchase without a subsidy. Therefore, it is recommended that the list of eligible technologies be carefully selected based upon stringent eligibility criteria so that incentives are only provided to the most efficient equipment. Box 5.16 demonstrates how eligibility criteria are developed in coordination with performance criteria to receive government fiscal support in the U.K.

Box 5.16: United Kingdom's Enhanced Capital Allowance: Eligibility Criteria for Hot Water Boilers over 400kW

To be eligible for an enhanced capital allowance in the United Kingdom, products must:

- Be gas and/or oil fired
- Use a forced draught burner (or burners)
- Have a nominal rated output in excess of 400kW at an average boiler-water temperature of 70ºC
- Automatically respond to changes in hot water demand by modulating their output in a continuous manner across the turndown ratio, as set out in the performance criteria below, without initiating a purge cycle
- Conform to the requirements of the Pressure Equipment Directive 97/23/EC with respect to their design, manufacturer and testing procedures
- Exceed the minimum performance set out below

Minimum Performance criteria

Products must have a minimum net thermal efficiency of 93 percent at full and partial load conditions as set out in the table below. Turndown ratios will depend on the type of fuel used.

Fuel	Turndown ratio	Test point % MCR	Net thermal efficiency %
Gas fired or dual fuelled	3.33:1	30	>=93.0
		50	>=93.0
		100	>=93.0
Oil fired	2:1	50	>=93.0
		100	>=93.0

Products must also have a standby loss of less than 0.02 kW per kW of the thermal rating. Required test procedures should be described in detail as well.

Source: *Energy Technology Criteria List – July 2007*. Crown: 2007. 23-24.

International experience shows that tax relief for specific energy efficient equipment creates incentives for all relevant market participants. These programs typically reach a large number of entities and are less likely to unfairly discriminate between potential participants. Box 5.17 shows examples of successful tax relief policies in other countries.

Box 5.17: International results from tax relief policies

United Kingdom: The British government introduced the 100 percent first-year Enhanced Capital Allowances program in 2001. This measure has resulted in energy efficient and environmentally friendly investments in 7,000 equipment units totaling over £3 billion.

Japan: The Energy Conservation and Recycling Assistance Law established accelerated depreciation for energy efficient equipment and led to installation of approximately 25,000 pieces of equipments each year from 1996 to 98.

The Netherlands: The Danish government introduced the Energy Investment Deduction program in 1997. Firms investing in energy savings could apply for tax deductions for eligible technology. Over 10,000 applicants benefited from €430 million of investments during the first year of the program implementation. Participation in the program peaked in 2001, when over 28,000 applications representing over €1 billion in claims were filed.

Sources: *Tax and Fiscal Policies for Promotion of Industrial Energy Efficiency: A Survey of International Experience.* Lynn Price, Christina Galitsky, Jonathan Sinton Ernest Orlando Lawrence Berkeley National Laboratory Berkeley, 2005.

Payable enhanced capital allowances HM Treasury, 2007.

Effectiveness of Subsidizing Energy Saving Technologies: Evidence from Dutch Panel Data. Aalbers, R.F.T., de Groot, H.L.F., Vollebergh, H.R.J., 2004.

Tax relief provided for the purchase of energy efficient equipment is an objective mechanism available to all market participants. Factors critical to the success of tax relief mechanisms include:

- A list of technologies with qualifying detailed technical criteria (see example in Box 5.16)
- Regular updates of the lists (in most countries – on annual basis)
- An extensive communication campaign targeted at relevant vendors and industrial end-users.

In Russia, it may be beneficial to use tax relief mechanisms for select types of energy efficient equipment like industrial boilers, infrared heaters, compressors, motors, and drives. For example, the modernization of inefficient industrial boilers is currently beneficial for the Russian economy, but not attractive for market participants. Market energy efficiency potential increases along with gas price growth. Tax relief incentives for the most efficient boilers can help to increase the financial viability of these investments for market participants and foster the replacement of old equipment with the best available technologies.

5.6 What are the barriers and solutions to energy efficiency in the heat supply sector?

Heat generation and distribution have great energy savings potential in Russia. Chapter 4 discussed the possibility of increasing energy efficiency of generation via investments in boiler efficiency, by reducing distribution losses through pipeline investments, and by further developing municipal heating systems.

Figure 56 shows some of the principal barriers in the heating sector, and prioritized solutions to those barriers. These barriers and solutions are discussed in more detail in sections 5.6.1 and 5.6.2, respectively. Some of the most significant barriers to energy efficiency in the heat supply sector relate to the application of tariff methodologies, the legal structure of Municipal Unitary Enterprises (MUPs), and a lack of sectoral coordination and information. The government should first focus on solutions that provide flexibility for MUPs to become commercial entities, improve the collection of statistical information, and develop municipal heat supply plans. Substantially reforming how tariffs are set will also benefit energy efficiency in the sector.

Figure 56: Barriers and Solutions to Energy Efficiency in Heating Supply

Barriers	Solutions	
▪ Inappropriate tariff methodology ▪ Political interference ▪ Cost plus method ▪ Tariff period is too short ▪ Legal structure and governance of municipal heat suppliers ▪ Lack of information and sectoral coordination	Quick Wins	▪ Reform tariff methodologies ▪ Price cap system ▪ Full cost recovery ▪ Transform municipal heat suppliers into commercial entities or PPP
	Essentials	▪ Coordinate municipal heat supply development plans

5.6.1 What is hindering energy efficiency investments in heating supply?

Russia faces a number of challenges in achieving the energy efficiency potential described in Chapter 4. Along with regulatory, split-incentive, and informational barriers that tend to hinder energy efficiency investments in multiple sectors, the heat supply sector faces additional obstacles due to its complex, yet regionally decentralized nature. Sector-wide disorganization, poor management, and lack of coordination further impede the overall efficiency of Russia's heat supply systems. Barriers to energy efficiency in Russia's heating sector include:

- **Lack of information.** A lack of information prevents Russia from running its heat supply systems efficiently, and deters investments in projects necessary to improve efficiency. More specifically, information is lacking on heat production and consumption. Russia has no data on the supply-demand balance in the heating sector. Very little metering exists at local boilers, within buildings or within apartments. For example, in 2006 only 8.7 percent of municipal boilers of heating suppliers in Rostov-on-Don were equipped with heat meters.[110] Without meters at the local boilers, there is no way to measure actual production. Without metering in buildings or apartments, there is no way to measure actual consumption. Without data on both consumption and production, there is no way to assess heating distribution losses. Without this data, neither producers nor consumers can have any knowledge of how much energy is being wasted and how much potential exists for saving energy. Supply and demand forecasts used to plan new construction can be nothing but spurious
- **Inappropriate application of tariff methodologies.** The way in which regulators set tariffs in the heating sector dissuades companies from making investments that would reduce the operating costs of heat production. More specifically:
  - There continues to be political interference in tariff setting. Political interference in the tariff setting process is both formal and informal. Recent federal legislation limits until 2010 the extent to which tariffs can increase. The government presumably sees these limits as a way to protect low income customers and, possibly, cushion the effects of price inflation. More generally, regulators are under constant informal (and implicit, if not explicit) political pressure to consider the negative social and political possible backlash of raising tariffs. This political interference keeps tariffs below their full cost-recovery levels, which dampens consumers' incentives to invest in energy efficiency. In a number of municipalities the level of residential tariff cost recovery is still low. For example, in Nizhnevartovsk, it is about 80 percent
  - The cost-plus tariff methodology used in Russia discourages heating suppliers from investing in any measures that save operating and maintenance costs (which include energy costs). With the cost-plus method used currently in Russia, the greater the cost base, the greater the profit margin earned by heat suppliers. As such, the producers' goal of maximizing profit contradicts with the objective of improving their efficiency
  - Any reduction in costs can (and nearly always is) passed through to customers each year as a reduction in tariffs, despite legislation to the contrary. According to Government Ordinance #109, tariffs for public suppliers who make investments to reduce their operational costs shall be allowed to keep the savings associated with their investment for

[110] Kovalchuk, ibid.

two years after the payback period calculated for the investment. However, observance of this provision remains at the discretion of the local authorities, and they rarely observe it. The intention of Ordinance #109 is good, but the approach is, in practice, very difficult to implement and is far from being the best way to set tariffs

- As in most other utility service sectors, tariffs do not yet reflect the full cost of distribution losses. Normally the allowed rate of distribution losses, which is used for calculation of distribution costs, is far below actual losses. For example, actual heat distribution system losses could average 20 percent and can reach as high as 36 percent, while only 13% losses are allowed by the regulators. As a result, if end-use is (at the building level) not metered, suppliers will produce less heat than required, as a way of recouping the costs of their higher-than-mandated distribution loss levels. If heat supplies are metered (again, at the building level), they will increase production beyond what is required as a way of recouping their losses (because they earn a margin on each unit of heat produced). These regulatory factors collectively reduce the economic attractiveness of investments in distribution pipeline renovation and lead to over-consumption of, or overpayment for heat.
- Short periods between tariff revisions. The time between tariff revisions is too short to allow for sufficient investment planning. Local authorities cannot set tariff levels for any longer than three years, but generally prefer to revise tariffs every year. In contrast, in Russia the revisions tend to introduce unpredictability thus discouraging long time capital expenditure, even if that capital expenditure would yield savings for the customer over time.

- **No ability to control consumption.** Customers in the heating sector typically have no way to control their comfort levels, short of opening their windows to control over-heating, or finding other heating sources (for example, by buying individual electric heaters) to control for under-heating. Apartment-level thermostats are typically expensive and require other rehabilitation of the heating system

- **Ownership, legal status, and organizational structure.** Many heating utilities are owned and operated by municipal governments (Municipal Unitary Enterprises or MUPs), and therefore lack the incentives and flexibility they need to improve performance. MUPs have no incentive to reduce costs, and therefore no incentive to improve energy efficiency. MUP's also have little autonomy in determining how retained earnings are used or cash flows are managed, cannot pay competitive salaries, and generally rely on municipal funding to accomplish any type of project requiring investment capital. Heating companies therefore have trouble attracting quality management and external financing.

- **Lack of inter- and intra-sectoral coordination.** There are 17,000 heat suppliers in Russia, with rarely any systematic intra-sectoral or inter-sectoral development and organization by local government authorities. Local and regional heat suppliers rarely coordinate with one another in planning rehabilitation or new investments, nor do local authorities coordinate with electricity, gas, or heat suppliers to ensure residents are being supplied with energy most efficiently and at lowest cost. For example, systems with low load density have higher distribution losses, but heat load density is rarely used to determine optimal investment decisions in heating infrastructure. In Moscow and other large cities, local boilers and individual heaters are being installed even though the cities already have well-developed district heating infrastructure. Increased installation of individual heaters is likely due to the poor quality of district heating or because individuals seek greater autonomy in their heat supply. Nevertheless, factors, such as quality of service and individual preference, can have a negative impact on the overall efficiency and costs of a district heating system.

5.6.2 What can the Russian government do to increase the energy efficiency of heating supply?

Improving energy efficiency in the heating sector will require a number of solutions. For Russia, approaches that are most likely to produce a significant impact include:

- **Tariff reform.** Tariff reform can do the most to improve energy efficiency in the heating sector. Steps toward tariff reform will require:
  - Raising base level tariffs to a level that reflects the full efficient costs of heat supply. Knowing what levels of costs are "efficient" can be difficult. If comparable cost data are available for a range of heat suppliers, regulators can benchmark one heat supplier's performance against another. If no such comparable data are available, regulators may therefore wish to set tariffs, initially, based on each heat supplier's actual costs for some historic year or average of years, but begin to collect data on other heat suppliers operating costs as a way of having comparators
  - Preventing political interference in the tariff-setting process. One possible, albeit not foolproof deterrent against political interference is widespread dissemination of information about costs, and the basis for decisions to raise or lower tariffs. Regulators are better placed to defend their positions if they publish data on costs, their analysis, and open their decision-making process to the public through public hearings
  - Methods for setting tariffs need to allow for the appropriate inclusion of investments costs in overall cost assessment. The risk that regulators will disapprove capital expenditures is preventing investments that may yield savings over the longer term. One possible solution to this problem is to extend the time between tariff revisions.

    A tariff cap or "price cap" regulatory regime is just one appropriate solution that can help to improve overall operational efficiency, and with it, energy efficiency in the heating sector. Tariff caps focus on outputs rather than inputs. Caps are usually set for a period of five years or longer, linked to service quality, and adjusted according to inflation and fuel prices. Tariff caps provide heat suppliers with incentives to cut their cost, and hence improve efficiency, in order to maximize profit. Regulators would not need to review the cost structure on an annual basis. After the end of cap period the regulator would review the cost structure and would share appropriate benefits with consumers. The main challenge of a cap system is that it requires sophisticated monitoring of service quality.

    As a transitional arrangement the cap method could be used for operating and maintenance costs only and combined with return on assets for investment costs. Section 5.7 contains additional recommendations on how the tariff setting process could be reformed. The recommendations contained here, and in Section 5.7, hold for all energy services in Russia: heat, electricity, and gas alike.

- **Transforming MUPs into commercial entities.** Transparency of operations and clear delineation of obligations will increase incentives for energy efficiency in MUPs. This can be done by either transforming MUPs into joint stock companies, engaging the private sector in the management, operation and financing of PPPs, or both. Granting the MUPs autonomous status creates the subsequent need for mechanisms to ensure transparency and good governance. Such mechanisms include the creation of independent boards of directors, the imposition of independent audits, and the creation of performance contracts defining the respective responsibilities of municipalities and heat supply companies. All of these requirements help to clarify the role of both the company and the municipality in the business relationship and hold each party accountable for their respective roles in capital investment.

Increasing the transparency and clarifying the parameters of these operations will increase the potential for outside financing, or the involvement or private operators. Increased transparency can help justify tariff increases, and put pressure on heat suppliers to improve efficiency. Involving the private sector through concessions or other forms of public-private partnerships may be an attractive option for increasing the efficiency of MUP operations. However, it is of paramount importance that the PPP process is transparent and competitive in order to effectively balance the interests of private investors and consumers alike. Early PPPs in the heating and water sectors in Russia were largely unsuccessful due to lack of transparency and competition. At the time, municipal governments did not have the necessary knowledge and capacity to prepare and manage these contracts. Often the private sector operator drafted lease/concession agreements which resulted in very biased risk allocation. Box 5.18 shows how private sector participation was introduced in the urban heating sector in Poland and Estonia.

Box 5.18: Some Successful Experiences with Early Attempts with District Heating Private Sector Participation

Poland: Poland has one of the richest experiences in introducing private sector participation in the urban heating sector. The systems in the cities of Kalisz and Walbrzych are two noteworthy examples. In both cases, the municipal DH utilities were transformed into joint stock companies, and long term (10-15 years) lease and performance contracts were signed with competitively selected contractors. Modernization plans included fuel switching, replacement of old boilers with new, efficient automated HOBs, replacement of pipes, etc. The large scale investments resulted in: significant improvement of the system efficiency (8 percent in Kalisz), doubling or even tripling of the value of the companies' assets, lower than average prices for the country, improved quality and reliability of service, and continued profit growth for the companies. Similar examples are available in many other Polish cities, in some cases through leasing or performance/operation contracts, while in others through partial sale of DH company shares to foreign companies to attract investment. Introduction of private management, rather than the change of ownership over DH assets, was the key to the effective modernization and improved economic operation of these companies.

Estonia: In Estonia the sale of shares and 30-year concession of the Tallinn Heating Co was organized through a tender, the evaluation criteria of which favored high concession payments, limited price growth, improved economic and financial operations, and experienced business management. The selected Dalkia subsidiary, Tallinna Küte, took over all assets, rights, liabilities, employees, and agreements of the Tallinn Heating Co under a so-called enterprise transfer concept for the concession period. In addition, the company committed to comply with the service features, environmental, safety and security requirements, monitoring rights, and extensive reporting requirements for the concessionaire; as well as set tariff caps defined by the city administration. As a result, the city received 210 million Estonian kroon as an initial payment and is receiving annual concession payments. The lack of cash for investments was solved well, losses have been reduced, profitability has increased, and the service quality has improved significantly. A significant portion of money from consumers goes to the city budget and can be used for other purposes.

Source: Pasoyan, Astghine. *Regional Urban Heating Policy Assessment Part 1.* Alliance to Save Energy. July, 2007.

- **Development and coordination of municipal heat supply plans.** Municipal heat supply development plans should be developed regularly and become the basis for development of the heating sector. Sector development programs should aim to redistribute heat loads, optimize the use of centralized and decentralized heating, and reduce pipeline distribution losses. As such, they will need to be able to accurately account for heat load density, heat generation capacity, heating consumption needs, electricity generation needs (in order to determine the appropriateness of CHPs), and other efficiency parameters. In some Russian regions, development program goals include: optimization of heat supply systems (e.g. Housing Modernization Program in the Republic of Karelia), heat load redistribution, improvement of efficiency of heat supply companies, loss reduction, balancing centralized and de-centralized heating, CHP development and metering (e.g. Energy Efficiency in Fuel and Energy Complex Program of the Yaroslavl oblast). Box 5.19 shows how Denmark planned the expansion of its public heating network

Box 5.19: Public Heating Plans in Denmark

With the passing of Denmark's first heat supply law in 1979 came the onset of the first framework for the country's public heat planning. The planning was divided into three phases. In the first phase, local authorities collected data regarding their heat requirements, the heating methods used, and the amounts of energy consumed. In addition, they assessed heat needs and heating possibilities and compiled reports of their findings. These were passed on to the county councils who, in the second phase of planning, prepared regional heat supply summaries. In this phase, local authorities also prepared a draft outlining their future heat supply. In the third phase, a definitive regional heat plan was developed that included local and regional recommendations. Specifically, the final plans showed the areas in which various forms of heat supply should be prioritized and where future heat supply installations and pipelines should be located. All the final plans produced by each authority had to be approved by the Ministry of Energy before they could be implemented.

As a result of public heat planning, the share of district heating in Denmark has increased from 29 percent in 1972 to 55 percent in 1988. This was partially due to the initiation of the 1986 Co-generated Heat and Electricity Agreement, which decentralized co-generated heat and electricity and the 1988 ban on the installation of electric heat in new buildings. The creation of the heating plans in 1979 led to such an increased awareness of energy efficiency that it created additional bans, reforms, and obligations for energy producers, distributors, and consumers.

Sources: *Heat Supply in Denmark – Who What Where and Why.* Denmark Energy Authority. January, 2005. http://www.ens.dk

- **Improved information collection.** Heat supply development plans must be based on credible information in order to be effective. Credibility of such information will rely upon:
  - Sector-wide metering of boilers and end consumers;
  - Creation of consistent, comprehensive and user-friendly forms for recording and reporting statistics. The Federal Tariff Authority would be well placed to develop standardized reporting forms which capture this information;
  - Periodic review of methodology for calculating distribution heat loss indicators in order to keep pace with technology development;
  - Development of an inventory of all heat loads and heating consumption needs by zones of heat distribution.

  The World Bank financed Housing and Communal Services project intends to develop and pilot such a monitoring system in 14 Russian regions.

  In addition to the improved collection and credibility of data at the local level, a federal level monitoring system should be in place to collect local and regional data and compile it for nationwide statistical purposes. Such an effort will be crucial to the success of the service quality benchmarking approach and tariff methodology recommended above.

5.7 What are the barriers and solutions to energy efficiency in the electricity sector?

The Russian electricity sector is in the process of undergoing extensive restructuring and privatization reforms. A number of positive changes have already been made including the introduction of new generating companies through privatization or RAO-UES' assets, the establishment of a spot market, the increase of unregulated power supply agreements, the continued increase of tariffs to move the electric utilities closer to full cost recovery, and the commitment of the government to pilot a new tariff methodology. These reforms will all help Russia to improve its energy efficiency. Figure 57 shows many of these solutions and the barriers they are meant to address.

Other barriers not currently on the government's radar include the general bias in the electricity industry to build traditional, new generation capacity rather than invest in energy efficiency, perpetuated by exaggerated demand growth projections. These barriers can best be removed by encouraging reduced consumption through demand side management. Barriers also remain to the most efficient siting of new generation plants in areas that remove grid constraints, and the most efficient selection of technologies (with CHPs as possible options). These barriers can be removed by standardizing and simplifying the rules for siting new plants and connecting those plants to the grid.

Figure 57: Barriers and Solutions to Energy Efficiency in Electricity

Barriers	Solutions	
■ Inappropriate tariff methodology ■ Bias toward new capacity ■ Exaggerated demand growth projection ■ Lack of coordination between energy service providers ■ Uncertainty over sector reforms	Quick Wins	■ Reform tariff methodologies ■ Regulated Assert Based tariffs ■ "Two part" tariff ■ Remove cross-subsidy
	Essentials	■ Demand side management or rate payer funded energy efficiency programs ■ Clarify and standardize requirements and procedures for siting new plants and connecting to the grids
	High Cost, High Return	■ Complete electricity sector liberalisation

5.7.1 What is hindering energy efficiency in the electricity sector?

Existing regulatory procedures, projected demand, and remaining uncertainties about the completion of sector reforms pose a threat to the continuation of Russia's transition to a competitive market, and with that transition, better electricity sector efficiency. More specifically, barriers to improving energy efficiency in the electricity sector include:

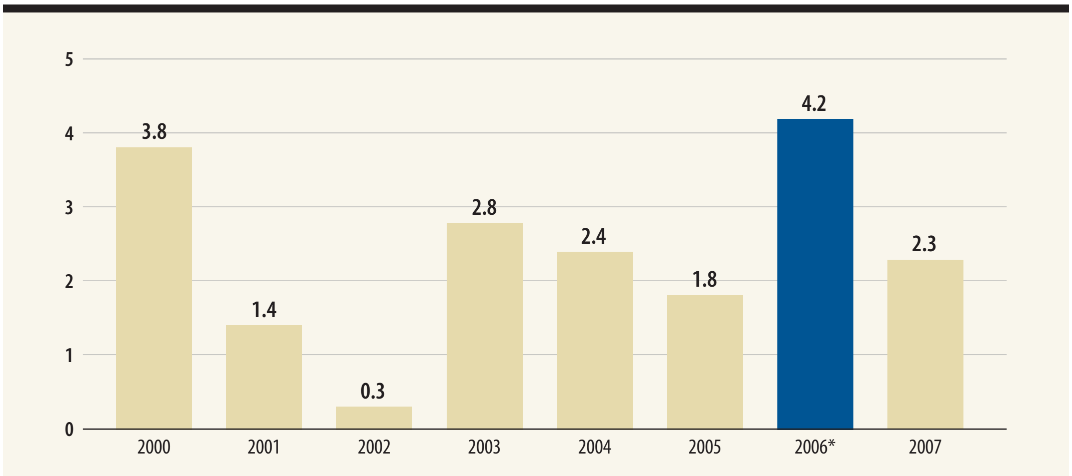
- **An inappropriate tariff methodology.** Electricity sector tariff-setting in Russia discourages companies from making long-term investments in energy efficiency. The tariff methodology used in the electricity sector is the same as in the heating sector, and therefore presents the same barriers for energy efficiency. The cost-plus tariff methodology, short period between tariff revisions, and continued political interference in the way tariff levels are set all discourage investments in energy efficiency. More generally, as mentioned in the introduction to this chapter, electric utilities around the world are often regulated in such a way that encourages more, rather than less, capital investment and sales to customers

- **Bias toward building new production capacity.** Russia's electric companies are not unique in this regard. Investing in energy efficiency is three times less expensive than the introduction of new capacity. Nevertheless, energy savings alternatives are consistently undervalued by electric utilities. Most energy companies around the world have an inherent bias to building new production rather than reducing consumption, and for good reason. This bias exists because these energy companies (whether in competitive or regulated environments) often earn more when they sell more, or earn more when they expand their asset base.[111] The returns on energy efficiency investments, in contrast, often accrue to individual consumers, and not to the electric utility, at least in the short term.

[111] The utility's incentives will vary considerably depending on how tariffs are set.

- **Exaggerated demand growth projections in Russia** further encourages investment in new capacity over investments in energy efficiency. This is particularly true when capacity needs are drastic as RAO's recent projections have made them seem. RAO-UES has projected that electricity demand in Russia will grow by nearly 5 percent per year, but RAO's projection is based on the extremely cold winter of 2005/06 in which electricity consumption leapt to 4.2 percent (from an average of 2.4 percent), and therefore may be overstated. Figure 58 shows annual consumption statistics for 2000 to 2007. The investment plans of the newly privatized generation companies accordingly include commitments, agreed with RAO and the Ministry of Economy, to introduce new capacity. Energy efficiency investments are (however incorrectly) viewed as inappropriate for meeting such large increases in demand.

Figure 58: Annual electricity consumption growth rates, 2000-2007, %



Source: RAO UES and Institute of Energy Policy, "Economic Results of 2006 in energy sector," 2007.

- **Extreme segmentation of electricity markets.** Segmented and poorly coordinated electricity transmission systems prevent competition in Russia, limiting opportunities to improve energy efficiency. The design of the electricity network in Russia does not allow companies to fully realize the advantages of cross-regional power trading. The location of generation capacity was based on the structure of Soviet economy, which does not match the now more concentrated areas of consumer demand in Russia. The Russian electricity system is divided into seven separate service areas (Far East, Siberia, Central, North-West, North Caucuses, the Volga, the Urals) with almost no transmission inter-connections between the European, Siberian, and Far Eastern Energy systems in particular. Within each electricity system, transmission bottlenecks exist due to the grid's limited carrying capacity. These bottlenecks effectively create separate zones, each with their own, uncompetitive energy prices. Currently, there are more than 6,000 price zones in the power market in Russia.
- **Lack of coordination with other energy service providers.** When planning to build new generating capacity, electric utilities do not consider heat demand or centralized heating plans. Although this is partially due to the fact that the electricity sector is more advanced than the heating sector in terms of reforms and quality of management, without coordinating their energy services, the two sectors can never realize their full energy savings potential. Federal, regional, or municipal governments could play a role in helping to plan the most efficient means of delivering energy in particular areas, but they do not

currently. The potential for distributed CHPs, for example, which could efficiently serve both heating and electricity demand while relieving transmission constraints in certain areas, is overlooked. RAO UES's General Scheme of Electric Power Objects Distribution to 2020 projects that CHP's share in total heat generation will increase only slightly above projected increases in heat demand.

- **Cumbersome rules for new plant siting and interconnection.** Industrial boilers could also potentially be replaced with CHPs, allowing factory owners to sell surplus electricity into the market. However, complicated rules for construction approval, grid interconnection, equipment certification, ecological standards, and noise level standards further hamper companies' abilities to invest in CHPs. These same rules prevent the efficient siting of any new generation not owned by incumbent electricity service providers. Incumbents typically avoid many of these rules because they build on existing sites and simply upgrade (rather than install new) connections to the grid.
- **Risk of slowing electricity sector reforms.** Some investors and experts see a risk that electricity liberalization reforms could be delayed and may not reach completion. The electricity sector reform was initiated and subsequently driven by a group of leaders mainly from the top management of RAO UES who were strongly committed to change in the sector. With RAO-UES' liquidation pending, sector reforms may not continue at their present rate. As recently as May 2008, the government again delayed the rules for wholesale and retail electricity markets, from the fourth quarter of 2008, to the first quarter of 2010. Reforms could continue to stall, especially under the influence of government-owned generation companies and other generators under the control of large energy and financial companies. There is also a risk that unbundled generation companies could establish oligopolistic arrangements that the government may not be able to control, further jeopardizing the success of the reforms.

5.7.2 What can the Russian government do to increase the energy efficiency of the electricity sector?

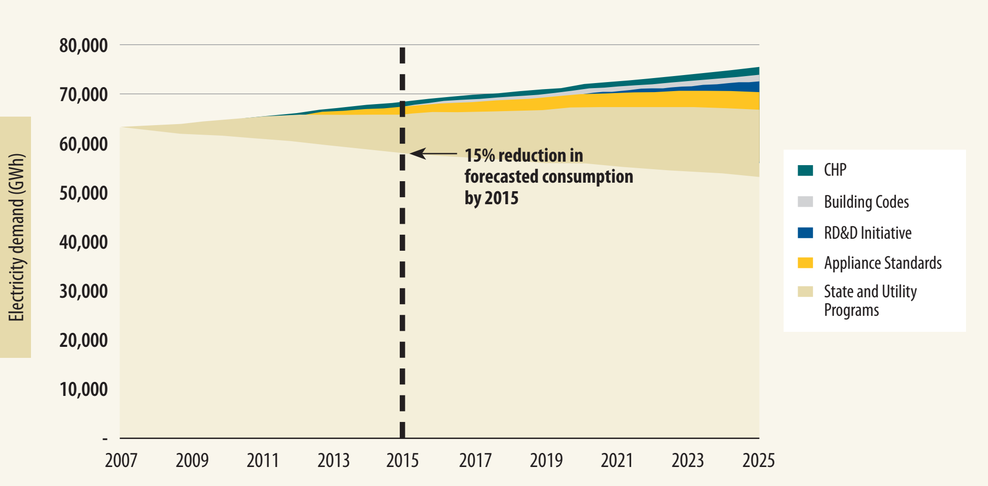
In addition to completing the reforms necessary to liberalize the electricity market in Russia, the government can continue to promote sound electricity sector regulation, including proper tariff setting for those segments of the electricity sectors that remain regulated, a relaxation of new plant siting and interconnection standards, and incorporation of DSM measures. As noted in the introduction to this chapter, a coordinated approach is likely to be more effective than piecemeal measures to improve energy efficiency. Box 5.20 shows how the state of Maryland intends to reduce electricity demand through a range of energy efficiency and DSM measures.

Box 5.20: Comprehensive electricity legislation in Maryland

The US state of Maryland faces growing demand for electricity in very much the same way as Russia. During the next 17 years, the base level scenario of projected demand is growth of roughly 20 percent. However, instead of building new generation and transmission capacities, the Maryland government chose to mobilize energy efficiency and demand response resources in order to forestall the prospect of power curtailment in future. In addition, Maryland set a goal to reduce per capita electricity usage 15 percent by 2015 and 29 percent by 2025.

Maryland has proposed numerous energy efficiency policies, which are expected to be enough to achieve their stated reduction goals and have been proven as the least cost resource to meeting the state's future energy needs. Among the policy recommendations are: electricity savings targets, implementation of most recent federal and state appliances standards, stringent residential and commercial building energy codes, clean energy R&D, combined heat and power systems, and DSM programs.

By implementing the various measures of this comprehensive legislation, Maryland expects to: reduce customer electricity bills, increase energy security, ensure a cleaner environment, and create a clean energy economy in the state. The figure below shows how each measure is intended to reduce Maryland's electricity demand in the coming 17 years.



Sources: *Energy Efficiency: The First Fuel for a Clean Energy Future.* Report Number E082. ACEEE. February 2008.

Solutions to the barriers described above include:

- **Clearly commit to continued electricity sector reform.** The government can only ease investor concerns about the progress of electricity market reforms by sticking to its declared timetables. There may be very good reasons for delaying reform, but if there are, these reasons must be made clear to investors, with subsequent clarity on the length of delays. In order to promote energy efficiency, the Russian government should ensure the continuation and completion of the market liberalization reforms already underway

- **Reform tariff methodologies.** As recommended with respect to Russia's heating sector, the current methodology for revising tariffs discourages energy service providers from making investments in energy efficiency (or, for that matter, any investments that save on operating and maintenance expenditure). The current "cost plus" tariff methodology, used in Russia's electricity as well as heating sectors, is a harmful distortion of regulatory practice elsewhere in the world. The cost plus methodology discourages any savings on operating and maintenance expenditure because the electric utility earns a markup on each unit of energy sold.

As noted in the introduction to this chapter, the government could further improve energy efficiency by:

- Adhering to the timetable it has set to raise average electricity tariffs to levels that allow distribution utilities to recover their costs, including the full cost of energy owed to (newly competitive) generators;
- Continuing to gradually reduce cross subsidization between customer classes. Where subsidies are still needed to protect low income customers, the government can consider using life-line tariffs or targeted subsidies (see Box 5.22).

Requiring that tariffs reflect volumetric consumption and not norms based on dwelling size or other characteristics. Where customers are not metered, the government will need to find ways to encourage the utilities or customers to install meters. Customers can easily be given incentives to install meters, as their bills under normative tariffs are often higher than under volumetric tariffs.[112] A further, albeit typically more expensive refinement to volumetric metering, is to implement time of use metering in conjunction with "smart meters". Box 5.21 shows an example of how time-of-use metering and smart meters have been used in Canada.

Box 5.21: Smart metering and time of use (TOU) tariffs in Canada

In June 2006, the Ontario Energy Board initiated a price pilot project to test the reactions and impacts on consumer behavior of Ontario's Regulated Price Plan TOU prices. The table below shows the pricing structure of the time and season-sensitive prices.

Time	Summer Hours (Aug 1 – Oct 31)	Price (in Canadian dollars)/kWh	Winter Hours (Nov 1 – Feb 28)	Price (in Canadian dollars)/kWh
Off-Peak	10 pm - 7 am weekdays; all day on weekends and holidays	3.5¢	10 pm - 7 am weekdays; all day on weekends and holidays	3.4¢
Mid-Peak	7 am - 11 am and 5 pm - 10 pm weekdays	7.5¢	11 am - 5 pm and 8 pm - 10 pm weekdays	7.1¢
On-Peak	11 am - 5 pm weekdays	10.5¢	7 am - 11 am and 5 pm - 8 pm weekdays	9.7¢

Time of use tariffs require specialized meters, known as smart meters, that can remotely and automatically access information on customers' daily and hourly electricity consumption.

The installation and use of smart meters in conjunction with consumer awareness of the variation in time of use prices (via monthly usage statements and pricing schedule refrigerator magnet) yielded the following results:

- 6 percent reduction in total electricity use
- Average customer savings of 2.74 Canadian dollars per month from reduced electricity consumption (at an average price of 5.9¢/kWh)
- Customers saved an additional 1.44 Canadian dollars per month from shifting energy use during critical load periods

Based on these results, 93 percent of customers would pay less with an RPP TOU pricing structure (versus the current two-tiered seasonal structure). The majority of customers (78 percent) involved in the pilot project said they would recommend a time of use pricing plan to friends and family. Awareness of how to reduce their bill, greater control over electricity costs, and environmental benefits were cited as the top three reasons for their satisfaction. 71 percent of customers involved felt that the difference in price points was large enough to encourage a shift in electricity consumption. Additionally, customers noted the value of the monthly usage statement and the refrigerator magnet in helping them monitor and reduce their monthly usage.

Source: *Ontario Energy Board Smart Price Pilot Final Report.* IBM Global Business Services and eMeter Strategic Consulting. July 2007.

[112] Further innovations on tariff design are also recommended. These recommendations are presented below under the discussion of demand response.

- **Consider regulatory mechanisms for decoupling an electric utility's profits from its sales.** Currently, four states in the U.S. have decoupled utilities' profits from consumption and eleven states use a partial decoupling mechanism.
- **Implementing DSM programs that encourage the utility to invest in energy efficiency.** For example:
  - Some governments further encourage utilities to invest in energy efficiency by adding an extra sum to electricity bills to finance DSM energy efficiency investments. In North and South Carolina, for example, regulators are considering allowing Duke Energy, a regional power provider, to charge customers as much as 90 percent of the cost of an unbuilt plant in order to invest in measures like smart grid and meter technology.[113]
  - Other governments specify a certain amount of energy that the utility must save each year. France, for example, requires gas and electricity suppliers to invest enough over three years to reduce projected demand by 54TWh.[114]

In the electricity sector, Russia seems to already have in mind an improvement to the current cost-plus methodology. The Ministry for Economic Development (MED) intends to pilot a Regulated Asset Base (RAB) methodology tariffs in a number of pilot regions of Russia starting from July, 1st, 2008. This pilot will expand to a larger portion of Russia in 2009. Under the new methodology, tariffs will be fixed for three-five years, and the regulator will allow for a 6 percent return on assets growing to 10 percent in 2011.[115] Expenses will be passed through directly to customers, without any mark-up (as is currently the case). The initiative is expected to stimulate more investment in transmission and distribution. Moreover, the three-five year or even longer fixed period for RAB tariffs will encourage distribution companies to cut costs and increase revenues.

Box 5.22: More efficient subsidization of low income customers

As a country implements electricity sector reform, tariff increases may place relatively more of a burden on lower income customers. Cross subsidies between customer classes are often of more benefit to middle- and upper-income customers than lower-income customers, and lead to inefficient levels of consumption among the customer classes receiving the cross subsidy, as well as those paying for it. Governments undertaking power sector reform often use targeted subsidies and lifeline tariffs as more effective mechanisms to help make electricity consumption affordable for lower-income customers.

Targeted subsidies: Problems with this method are that it is difficult to agree on the exact qualifications of categorizing the poor. Possible criteria are income, location of household (since poor tend to live in specific areas), or households without service. A well implemented targeted subsidy provides assistance to only the specific people who qualify while also sustaining incentives for efficient use. An administration that oversees and identifies eligibility for the program is a requirement for the subsidy to be targeted. Another qualification for implementation is that it should be financially viable for the state to not only support the subsidy but to fund the institution behind it. In fact, targeted housing subsidies have already been proven successful in Russia.

Lifeline tariffs: Most of the poor require only the most basic amount of electricity. Lifeline tariffs offer a chance for poor low volume electricity users to receive this small block of electricity at a reduced rate. These tariffs set a limit to the amount of electricity subsidized, usually 50–100 kWh per month, and all additional units are sold at a slightly increased rate in order to offset the lost revenue. The general idea behind these tariffs is to make the bare minimum of energy necessity available to everyone. Proper implementation of the limit has to reflect this premise: if it is set too high the program would be supporting more than basic energy needs and a free rider problem of average users benefiting from reduced rates would exist.

Source: The World Bank. *Energy and Development Report 2000: Energy Services for the World's Poor.* Ch. 7: The Role of Energy Subsidies, p.60-66.

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113 Lavelle, Marianne. "When saving power means higher profits." U.S. News and World Report. 28 April 2008. 47.

114 "Energy Efficiency: The Elusive Negawatt." The Economist. May 8 2008.

115 www.kommersant.ru

- **Clarify and standardize requirements and procedures for siting new plants and connecting to the grid.** Russia can thereby encourage the private sector to build the most efficient type of generation, and in the areas where it is most needed to relieve transmission constraints, by clarifying and standardizing regulatory requirements for siting new plants and connecting to the grid. Co-generation is, as shown in Chapter 4, often the most efficient means of generating energy. Distributed generating facilities, when located near isolated pockets of load, can help to remove transmission bottlenecks and improve overall reliability. Without a more liberal regime for siting and connecting new generating resources, Russia's electricity system will get only what the incumbent electric utilities want to build, which may not always be what the system actually needs

5.8 What are the barriers and solutions to energy efficiency in the transport sector?

With rising economic growth and per capita income, reliance on road transport is increasing rapidly in Russia. As shown in Chapter 4, personal vehicle use is increasing, and with it, fuel consumption. This tendency is likely to persist in the future and if it does, will worsen, not improve, Russia's energy efficiency in the transport sector. Negative effects from increases in road transport may be further compounded by the fact that the majority of road transportation takes place in urban areas. Hence, fundamental structural and modal shifts in the sector and progressive metropolitan area reshaping promoted by comprehensive policy measures and political will are indispensable to prevent negative effects brought about by those changes. Figure 59 summarizes these barriers and prioritizes their solutions.

Figure 59: Barriers and Solutions to Energy Efficiency in the Transport Sector

Barriers	Solutions	
■ No incentives to travel efficiently ■ Consumer preferences for less efficient transport ■ A lack of information ■ Poor quality of public transport ■ Lack of financing for public transport ■ No integrated policy on sustainable transport	Quick Wins	■ Tighten fuel efficiency and emissions standards ■ Reward drivers who opt for more energy efficient transport options ■ Encourage changes in behavior through information dissemination ■ Introduce fuel efficiency labeling for new cars
	High Cost, High Return	■ Take an integrated approach to transport planning ■ Offer better quality of service on public transport ■ Charge users the full cost of private vehicle usage ■ Tax drivers for private vehicle usage

5.8.1 What is hindering energy efficiency improvement in the transport sector?

The principal barriers to energy efficiency in the transport sector are:

- **A lack of information.** A shortage of statistical data and studies on energy use in transport prevents the government from having a clear understanding of trends in energy use, and therefore prevents sound policy decisions to promote energy efficiency. Some information on vehicle stock, passenger and freight turnover, average mileage traveled, and specific fuel consumption exists, but is often contradictory. The shortage of information is especially acute with respect to privately owned vehicles.
- **No integrated policy on sustainable transport.** The government has yet to develop a consistent policy on sustainable transport, which typically integrates land use, urban planning, traffic management, and intelligent transport systems. Efforts are seldom made to link urban, land-use and transport planning policies. The government has generally focused its efforts on providing more space and roadways for use by private vehicles, rather than developing public transport or fostering the development of "sustainable cities" with improved access to places of work, goods, and services.

  The government has similarly paid little attention to improving freight transport management. Infrastructure for large-capacity long-distance carriers leaves much to be desired in Russia. Very often distribution centers are located within metropolitan areas and there are no spatial and temporal truck restrictions. Similarly, little has been done to promote a shift towards sea and river transportation which are generally more energy efficient than road or rail transport.
- **No policy incentives to travel more efficiently.** Private vehicle owners are not charged the true cost of infrastructure usage, congestion, pollution, and climate change. The ineffective use of transport tax policy significantly adds to the problem of the sector bias in favor of private vehicles. Those who contribute more to pollution and traffic and use fuel less efficiently, bear the same cost of infrastructure usage as those who travel less, during off-peak periods, or have more energy efficient and less polluting cars.

  Policy measures that might recoup some of these costs, and simultaneously influence vehicle purchasing and usage habits are used ineffectively in Russia. Regional governments do apply an annual transport tax, linked to the horsepower of the vehicle, but collection rates are low. The tax itself, moreover, is too low to have much of an impact on vehicle ownership or choice of vehicle.[116] Some fuel consumption norms also exist (Norms on Fuel and Lubricant Consumption in Motor Transport), but these are primarily to provide a basis for companies' financial reporting, rather than to encourage energy efficiency. In January 2008, Russia adopted Euro 3 emissions standards for imported cars, but these standards apply only to new imports and newly produced cars. In addition, enforcing Euro 3 emissions standards will prove difficult as many car engines do not even comply with Euro 1 standards and fuel quality, especially in remote regions of Russia, often does not meet this new standard and can deteriorate the high quality engines of newer cars mandated by the standard.

[116] Tax rates differ by region. In Moscow, where tax rates tend to be the highest, the tax for vehicles of 250 horsepower or greater is only 100 Russian rubles , or $ 4.22 per horse power, and will increase to only 150 Russian rubles, or $ 6.33, in 2009. For vehicles with 200-250 horsepower, the rate is even lower at 50 Russian rubles ($ 2.11) per horse power currently and 75 Russian rubles ($ 3.16) in 2009.

- **Poor quality of public transport service.** The public's preference for private cars is not without reason. City buses, suburban electric trains, and metro are not user-friendly: they are mostly overcrowded, uncomfortable, unreliable, and slow. Door-to-door connectivity is also poor. Main mass transit routes are often not complemented by feeder bus and para-transit routes, and inter-city transport systems are not integrated with suburban ones
- **Lack of available financing.** The lack of access to financing affects regional and municipal governments as well as individuals.
  - For regional and municipal governments, with whom responsibility for infrastructure construction resides, lack of access to financing appears to be a serious impediment to investing in infrastructure that promotes efficient energy transport. As has been described in discussions of barriers in other sectors, municipalities typically have no access to medium- and long-term financing. Municipalities also typically have difficulty entering into long term contracts that might allow for Public Private Partnerships to help finance public transport or other sustainable transport projects.
  - For individual consumers, the less efficient vehicles are typically the cheapest. Whereas a consumer might prefer a more efficient vehicle, the upfront costs of these more efficient cars are more than they can afford.
- **Consumer preferences for less efficient means of transport.** In shopping for cars – if Russian consumers consider a car's energy efficiency characteristics at all – they are generally unwilling to sacrifice power, size, and luxury for energy efficiency. This tendency contrasts with the one observed in European countries, where petrol prices are considerably higher and people are more concerned with environmental issues.

5.8.2 How can Russia improve energy efficiency in the transport sector?

Removing barriers to energy efficiency in the transport sector will require a combined approach focused on integrated transport planning and promoting behavioral changes towards wanting to use efficient transport among the population, while giving incentives to individuals to cut back on fuel consumption and the use of inefficient vehicles. New York City provides a successful example of a sustained and strategic approach to transportation efficiency. Former Mayor Guliani put a lot of emphasis on promoting the use of public transport among the middle- and upper-class. This targeted behavioral/informational campaign was combined with significant improvements to public transport, including increased frequency of routes, better punctuality, etc. Now, New Yorkers find public transport more efficient, quick, and comfortable. Efforts have been so successful that the new mayor Bloomberg now intends to further increase efficient use of transport by introducing congestion pricing schemes.

Russia can remove barriers to energy efficiency in the transport sector by:

- **Collecting better information.** Any solution the government chooses to pursue will depend on the development of better systems for collecting and analyzing data on the transport sector. A system of consistent transport sector development indicators needs be to applied at federal, regional, and local levels to evaluate the progress of urban and transport changes
- **Taking an integrated transport planning approach.** One-off policy measures to improve energy efficiency in transport are unlikely to yield as much improvement in energy efficiency as measures that are closely integrated with policies on urban development, land-use, and environmental preservation. Such integrated policies should emphasize an urban planning component, in particular, as most of the related problems (energy inefficiency as well as environmental degradation, poor air quality, congestion, etc.) and resulting benefits more acutely affect the urban population.

It is vitally important that municipalities elaborate and follow metropolitan area development strategies promoting citizen-friendly and sustainable urban designs that reduce the need to travel. Better integration of residential, business, commercial, and cultural areas, as well as optimized public transport access to mostly visited urban developments should be ensured. Many European countries managed to achieve this: More than 30 percent of car trips are less than 3 km long and 50 percent of car trips are less than 5 km long.[117] One may say that geography and country area is important here; however, policy plays a major role.

- **Offering a better quality of service on public transport, and better intermodal solutions (e.g., private to public and vice versa).** Most transport policy measures will also fail unless such measures are accompanied by improvements in the safety, reliability, and quality of public transport alternatives. For example, Moscow is now building new roads, or expanding the capacity of existing roads. However, international experience has shown that more roads mean more traffic, and more congestion over time, not less. Any efforts to reduce congestion in Moscow, such as congestion pricing or vehicle restrictions, are likely to backfire. The Moscow subway is already at nearly full capacity. Moreover, existing rail stations outside the city are few, and those that do exist are unsafe and offer no parking. In order to solve these problems, the government will need to look at a broad range of possibilities for strengthening links among major mass transit routes, and improving inter-modal transport.

  The restriction from entry into Moscow of trucks with emission levels below Euro-2 standards, which will become effective September 2008, is also likely to cause a wave of criticism, since many important distribution centers are located in metropolitan area and many essential trucking routes run through the capital center.

- **Charging users the full cost of private vehicle usage.** Only by charging the full cost of private vehicle usage will the government (or, to the extent that concession-type PPPs are used in Russia's transport sector, the private sector concessionaire) have sufficient revenues to maintain and rehabilitate infrastructure, and ease congestion through infrastructure expansion. Debilitated, congested infrastructure leads to significant energy inefficiency in the transport sector.[118] There are about 3.5 million cars in Moscow. According to some estimates each of these cars spends on average 40-45 hours per month in traffic jams. Assuming a car consumes one liter of fuel during an hour of idling, car owners waste more than $ 1.85 billion in Moscow during the course of a year.[119]

  Government or private operators can reduce reliance on private vehicles and ease congestion by charging road tolls, peak-hour fees, or parking pricing. Box 5.23 shows two examples of good integrated transport system planning through road price and improved quality of public transportation in Singapore and London. Congestion charges may, for example, make good sense in Moscow and St. Petersburg. Charges can be levied on the use of not only individual roads, but also local road networks and even wider areas with the emphasis shifting to charging the distance traveled rather than targeted bottlenecks. Toll roads might be a partial solution where traffic is high. A fuel tax is also a reasonable substitute for such a travel charge.

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[117] IPCC's Fourth Assessment Report.

[118] The Asian Development Bank estimates that the cost of traffic congestion alone constitutes as much as three percent of GDP in OECD countries and reaches six percent in some Asian countries.

[119] http://www.smilink.ru/

Box 5.23: Managing congestion in Singapore and London

Singapore: In 1975, Singapore introduced a scheme that levied a charge for the right to enter a 6 km^2 zone covering the central area during morning peak hours, unless the vehicle had four or more passengers (€1/day or €20/month). In 1998, this was replaced by an electronic system with smart cards in the vehicles. The pricing is based on a per-trip-system with highest tolls in the peak hours. Taxis were equipped with transponders which allowed them to avoid traffic congestions. In addition, Singapore introduced one of the highest import duties and purchase taxes on cars. The government also introduced individual working hours for various groups of public institutions to avoid creating rush hours. With the introduction of this scheme in 1975 there was a reduction of car peak traffic by 45 percent - and in the last 30 years it stayed on this low level without any major increases. The use of public transport by commuters rose from 46 percent to 65 percent.

London: Since 2003 motorists driving in central London on weekdays between 7:00 am and 6:30 pm are required to pay £5, increasing to £8 in July 2005. The cost of the system was £200 million which seemed too high but just in the first year the city already received £80million from users. The outcomes of the initiative were impressive. During the program's first few months automobile traffic declined about 20 percent (a reduction of about 20,000 vehicles per day), resulting in a 10 percent automobile mode share. Most people change their travel patterns due to the charge transfer to public transport, particularly bus. Some motorists who would otherwise drive through Central London during peak periods shift their route, travel time, or destination. Others shift mode to taxis, motorcycles, pedal cycles, or to walking This has significantly increased traffic speeds within the zone. Average traffic speed during charging days (including time stopped at intersections) increased 37 percent, from 8 miles-per-hour (13 km/hr) prior to the charge up to 11 miles-per-hour (17 kms/hr) after pricing was introduced. Number of cars decreased by 40 percent. Peak period congestion delays declined about 30 percent, and bus congestion delays declined 50%. Bus ridership increased 14 percent and subway ridership about 1 percent. The introduction of the system was combined with significant improvements in public transport such as dedicated bus lanes, more frequency, upgrade of metro, and other measures.

Source: World Energy Council and Victoria Transport Policy Institute. "London Congestion Pricing: Implications for other cities, 2006." Harvard Business Review-Russia, May 2008.

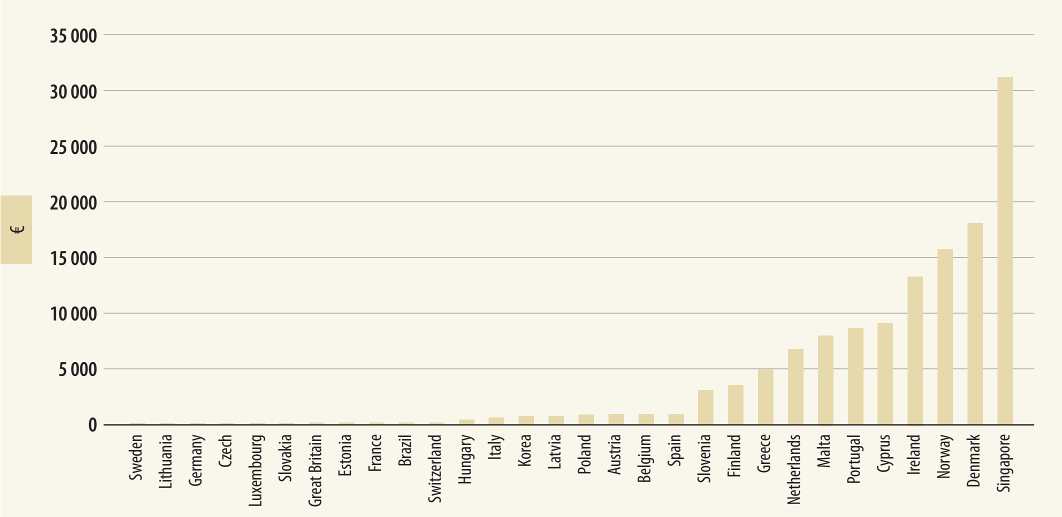
- **Taxing drivers for private vehicle usage.** Increased private vehicle usage accelerates wear and tear on road and transport infrastructure, and causes costly congestion and pollution. Where the government cannot recover the full costs of private vehicle usage through tolls or other charges, it can use fiscal policy tools. Governments often use fuel and vehicle taxation, vehicle registration fees, or vehicle purchase taxes to recoup the costs of private vehicle usage to infrastructure, and to society (as negative externalities), while simultaneously discouraging less efficient means of transport by making such use more expensive. Russia's current annual vehicle tax is a reasonable idea, but would need to be increased and made more progressive in terms of taxing more powerful cars to have much of an effect on vehicle purchasing habits

  Some countries use a specific tax on car purchases which stimulates consumers to buy more efficient and environmentally friendly cars. As Figure 60 shows, the highest car purchase taxes are observed in Singapore, Denmark, Finland, and Norway. Denmark and Norway also have high annual tax on cars, reaching as high as €300-450 per year.[120] Annual car ownership taxes complement vehicle purchase taxes and in most countries are linked to fuel consumption by the car in question, often including environmental and energy efficiency aspects. This tool is widely used in the EU.[121] Fuel taxes may ultimately be a better tool for Russia as they link payments to automobile usage rather than ownership.

120 WEC *EE policies around the world: Review and Evaluation,* 2008.

121 Instead of a tax, some Asian countries use purchase limitations, which are based on an open bidding process for certificates of entitlement to own a vehicle, combined with high initial registration cost and annual road tax.

Figure 60: Average car purchase taxes around the World



Source: World Energy Council.

A number of countries also make use of motor fuel taxes. In European countries these taxes are much higher than in the rest of the world. They are an essential source of government income: 10-15 percent of total state revenues are ensured by fuel taxation.

- **Rewarding drivers who opt for more energy efficient transport options.** In addition to discouraging energy inefficient behavior, the government will want to consider how to directly encourage energy efficient behavior. The city of Moscow offers an excellent example of thinking in this direction. The mayor has proposed that buyers of small cars and hybrid vehicles be exempt from transport tax, and be offered parking free of charge. Similar incentives are offered in cities throughout the U.S. In San Jose, California, for example, owners of hybrid electric vehicles and zero emission vehicles qualify for free meter parking downtown. Similarly, the state of California grants high occupancy vehicle lane access to hybrid vehicles regardless of the number of occupants of the vehicle.

- **Tightening fuel efficiency and emissions standards.** Russia could further improve energy efficiency in transport by imposing more rigorous energy efficiency and vehicle emission standards on domestically produced and imported cars. The less efficient fleet should be phased out and its replacement with a new, more energy efficient fleet be encouraged. This process is actually ongoing in Russia, as people are replacing their less efficient domestically manufactured cars with more efficient imported ones. Nevertheless, the combined market share of Russian brands remains around 60 percent, which indicates significant remaining potential for improvement. Box 5.24 describes China's experience with the recent introduction of fuel efficiency standards.

Box 5.24: Vehicle Fuel Efficiency Standards in China

In 2005 the first fuel efficiency standard – Fuel Consumption Limits for Light Duty Passenger Vehicles – was introduced in China. The main goal of this regulation was to help control the national total oil consumption to less than 400 million metric tons per year. The components of the vehicle fuel efficiency standard were (i) the development of weight-class based maximum fuel consumption standard; (ii) an overall per-distance fuel consumption reduction of 15 percent; and (iii) a more stringent standard for heavier vehicle classes to prevent a shift to heavier vehicles and to encourage the use of economic compact cars.

The first phase of the standard, targeting a reduction of 5 percent in per-distance fuel consumption was implemented in 2005, and a second phase, with a goal of 10 percent reduction in fuel consumption for each weight category in 2008.

With the implementation of this fuel economy standard, it is forecast that 13 million tons of fuel will be saved in 2020 and 31 million tons in 2030. However more stringent fuel economy standards need to be put into force after 2009. A further reduction of 25 percent in vehicle fuel consumption to 5.6 L/100km (the European requirement for 2008) should be established by 2012 for light-duty passenger cars and a fuel consumption level of about 4.8 L/100 km should be developed to catch up with Europe and Japan by around 2016. If this were implemented, an additional 19 million tons oil would be saved in 2020 and 60 million tons in 2030.

Source: Asian Development Bank *EE and Climate Change Considerations for On-road Transport in Asia.*

- **Introduction of new car labeling.** Mandatory new car labeling could be used to complement the introduction of standards. Such labels would include mandatory data on CO_2 emissions and fuel consumption. In some countries, such labels even include an efficiency rating system and additional data like noise level, emissions standards, taxes, and other technical data. Car labeling is widely used by the EU and Australia. In fact, the EU Directive (1999/94/EC) requires manufacturers and distributors to display information on fuel economy and CO_2 emissions on new passenger cars in showrooms. European countries' experience shows that fuel consumption can be reduced by 4-5 percent by means of labeling and raising consumer awareness.[122]
- **Encourage changes in behavior.** Better information, tax policies, and financial incentives can all help to initiate changes in behavior, but ultimately, if Russia wants to catch up to some of its European neighbors in terms of energy efficiency, improving energy efficiency will require a change in consumer values and preferences. The preference for larger, more luxurious vehicles reflects, in many countries, the importance of personal vehicles as a status symbol. The government can encourage the change of behavioral patterns that make people buy larger, more powerful, and more luxurious cars. The government can help to lead a change in public values, emphasizing, perhaps that cities are meant and designed for people, not for cars. This can be done by raising people's awareness of the fact that their health and quality of life is actually damaged by the rising number of private cars, or increase in air pollution, or involving local community groups or interest groups in the change process. Consumer preferences can be changed, and there is proof in Europe and the United States that smaller, more efficient vehicles have now become status symbols among some consumer groups.
- **Establishment of car scrapping schemes.** Governments in other countries have tried to help speed up the renewal of the car fleet by providing fiscal incentives for scrapping old cars. Other countries' experience show that in most cases the positive environmental effects achieved through the removal of the old fleet from operation outweighs additional energy use in car production and recycling. Individuals can be rewarded for actual scrapping regardless of the subsequent replacement decision, or for replacement with bonuses depending on a kind of replacement. The benefits of a scrapping scheme in Russia may be limited as incomes are still relatively low and older, used cars are therefore preferred to newer, more efficient cars simply because of cost.

[122] WEC *EE policies around the world: Review and Evaluation,* 2008

5.9 Gas Flaring

As described in Chapter 2, roughly one third of the flared Associated Petroleum Gas (APG) in Russia could be utilized at current APG prices, potentially generating incremental annual revenues of up to $2.3 billion per year. The regions of Khanty Mansiysk, has actively promoted flare reduction for some time, but Russia still has significant progress to make in addressing the issue. Figure 61 shows the principal barriers to energy efficiency in gas flaring and prioritizes possible government solutions.

Figure 61: Barriers and Solutions in Gas Flaring

Barriers	Solutions	
■ Remoteness of potential markets ■ Market structure that prevents third party access to spare pipeline capacity ■ Low price of dry natural gas and APG ■ Insufficient information on volumes of APG flaring and utilization ■ Soft penalties for excessive gas flaring	Quick Wins	■ Improved monitoring and enforcement of utilization requirements, possibly through an independent regulatory body
	Essentials	■ Enact Federal legislation requiring APG utilization, including heavier fines and possible loss of operating licenses ■ Allow third-party access to Gazprom pipelines
	High Cost, High Return	■ Continuing liberalization of gas prices

A recent study by PFC Energy, commissioned by the World Bank/Global Gas Flaring Reduction Partnership, demonstrated the financial viability of several different options for the utilization of APG depending on size and location of the fields. Nevertheless, a number of regulatory, geographic, and structural conditions prevent Russia from utilizing APG. These include:

- Remoteness of potential markets.
- The current market structure, under which Gazprom, as a monopoly, controls access to gas transport infrastructure, prevents many producers from bringing APG to market. Although the Russian government requires that Gazprom give third parties' non-discriminatory access to spare pipeline capacity, if Gazprom has no spare capacity, or claims to have no spare capacity, then independent producers are prevented from utilizing their APG.
- Low prices for dry natural gas and for APG bought by gas processing plants. With such low prices, producers have little incentive to make investments to collect and sell the gas.
- Insufficient accurate information on the volumes of APG flaring and utilization.
- Existing penalties are not high enough to discourage gas flaring. Regulators can charge an emissions fee to producers exceeding their flaring limits, but that fee is only $0.77 per Mcm and cannot exceed $1,540 per year.

The Russian government is starting to take steps to limit gas flaring and increase the utilization of APG. The following highlights the measures the government has already implemented:

- A 1997 decree (No. 858) giving third party's non-discriminatory access rights to spare pipeline capacity, providing their gas meets pipeline quality standards.
- An audit of all existing gas flaring systems by the industrial inspectorate by March 1, 2008.
- Increased fees for methane emissions, including flaring. Operators must pay 50 Russian rubles per ton for emissions below the permitted limits and 250 Russian rubles per ton for emissions above the approved limit.
- The price of APG has been de-regulated and the price of gas delivered to industrial users in Russia is being steadily increased.

In addition, the following measures, which may or may not be implemented and enforced, have been proposed by Russian policymakers:

- Plans to introduce legislation requiring oil producers to increase their utilization of APG to 95 percent by 2011.
- Plans, announced by the Ministry of Natural Resources, to increase flaring fines five-fold starting in 2009.
- Draft legislation requiring oil companies that use less than 95 percent of their APG to pay a mineral extraction tax.
- A 2007 proposal by the Ministry of Industry and Energy to give APG priority access to Gazprom's pipelines.

The Russian government has made progress in addressing the negative environmental and economic impact of gas flaring. However, it has yet to develop a comprehensive plan for incentivizing the use of and penalizing the flaring of APG. No one policy mechanism or legislative measure alone will be enough to fully realize Russia's APG utilization potential. Without an overarching plan that legislates, monitors, and enforces gas flaring limits while providing both rewards for compliance and penalties where appropriate, the Russian government will not reach its target for 95 percent utilization by 2011, or even by a significantly later date. Box 5.25 provides a discussion on various international approaches to this problem. Such a plan might include the following:

- Federal legislation requiring APG utilization or limiting gas flaring, and possibly including APG utilization requirements in all oil production licenses;
- Heavier fines for gas flaring with respect to field size and location, including a possible loss of operation licenses;
- Improved monitoring and enforcement of utilization requirements, including a clear and transparent distinction between regional and federal inspection responsibilities;
- Enforcement of third-party access to Gazprom pipelines;
- Creation of an independent regulatory body to oversee pipeline access and tariffs;
- Continued liberalization of APG and natural gas prices ;
- Priority access for APG in gas transmission networks;
- Identification of unused gas transmission capacity.

Box 5.25: Best practices abroad for APG utilization

Several countries, including Norway, the United Kingdom, Canada, and the United States, have developed comprehensive plans to increase APG utilization in oil production. These countries have employed several policy mechanisms that have led to successful reductions in gas flaring. These best practices include: legal flaring limits, government agency reviews of new field development, rigorous monitoring and reporting requirements, and escalating penalties, including license termination. Additionally, introduction of a policy mechanisms meant to capture climate change and environmental externalities increases incentives for APG utilization. The following example demonstrates the specifics of Norway's successful efforts to reduce gas flaring.

Norway: Since 1971, Norway has had policies restricting gas flaring from Norway's oil fields. The scope of these policies has developed substantially since then. Under the legislative authority of Norway's Petroleum Act and under the supervision of Norwegian Petroleum Directorate (NPD) and the Norwegian Pollution Control Authority, the country has developed a comprehensive approach to increase APG utilization. Specific conditions that have led to reduced levels of gas flaring include:

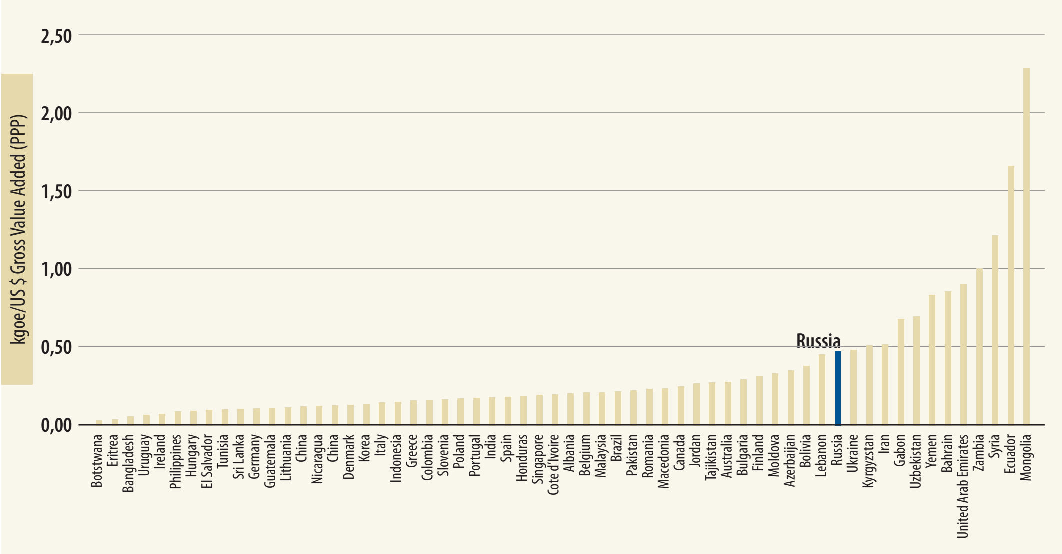
- Direct government regulation of emissions and environmental impact assessments
- Transparent process for reporting and monitoring
- Open-access gas transport infrastructure for all producers, replacing the previous system in which Statoil maintained sole control of the transport infrastructure
- CO_2 tax

Flaring restrictions have been credited for successfully creating incentives for the development of gas transport and processing infrastructure, enhanced recovery, as well as new technologies for utilization. Since the 1970s, oil production in Norway has increased significantly, but gas flaring volumes have remained stable or declined. In 2004, Norway producers only flared 0.16 percent of the total associated gas produced in the year.

Source: PFC Energy. 2007. *Using Russia's Associated Gas.* Prepared for the Global Gas Flaring Reduction Partnership and the World Bank. 18-45.

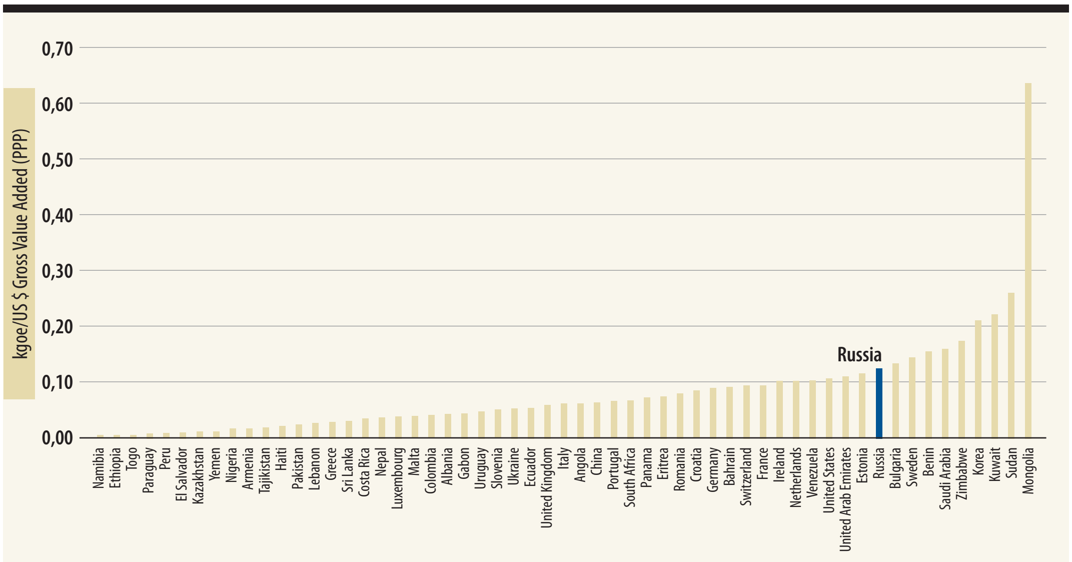
Appendix A: Comparison of Global Energy Intensities by Sector

Figure 62: Comparison of Global Energy Intensities of Manufacturing



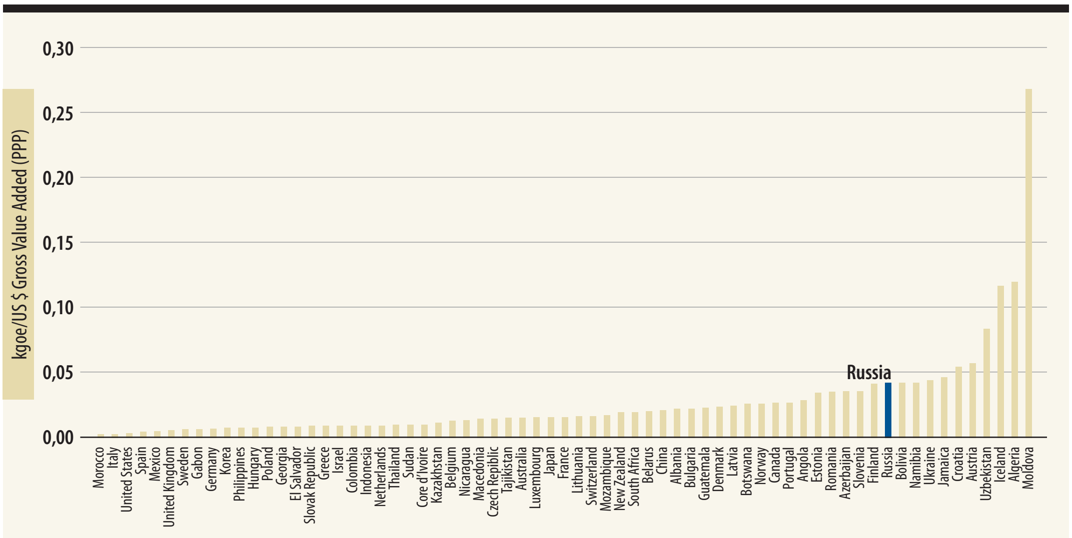
Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor. Data from the World Bank Development Indicators Database.

Figure 63: Comparison of Global Energy Intensities in Wholesale, Retail Trade, Restaurants and Hotels



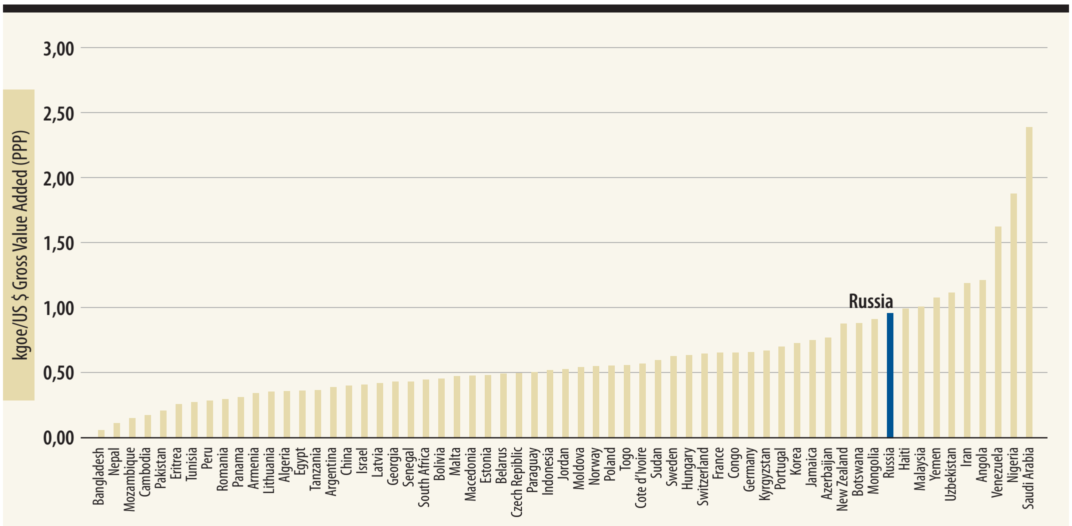
Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Figure 64: Comparison of Global Energy Intensities in Construction



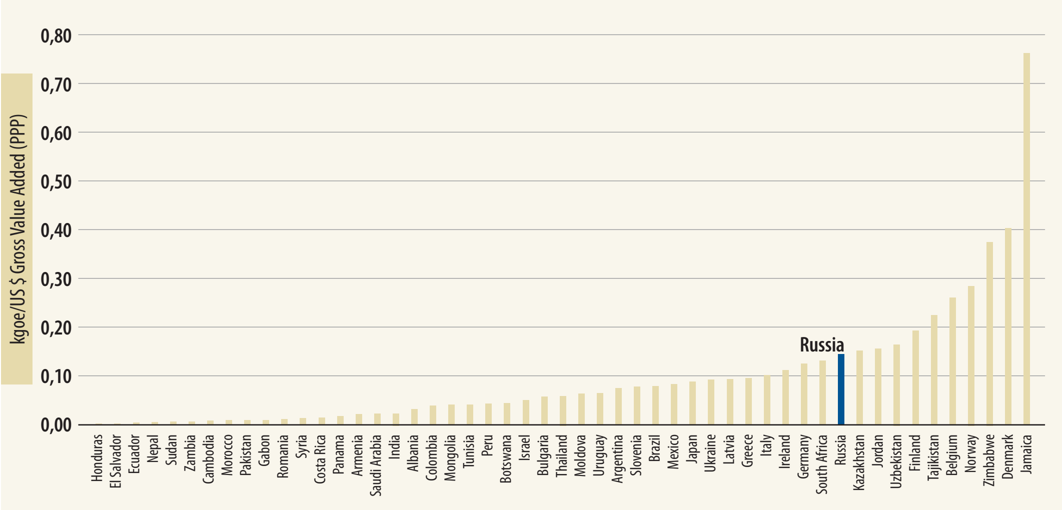
Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Figure 65: Comparison of Global Energy Intensities in Transport, Storage and Communication



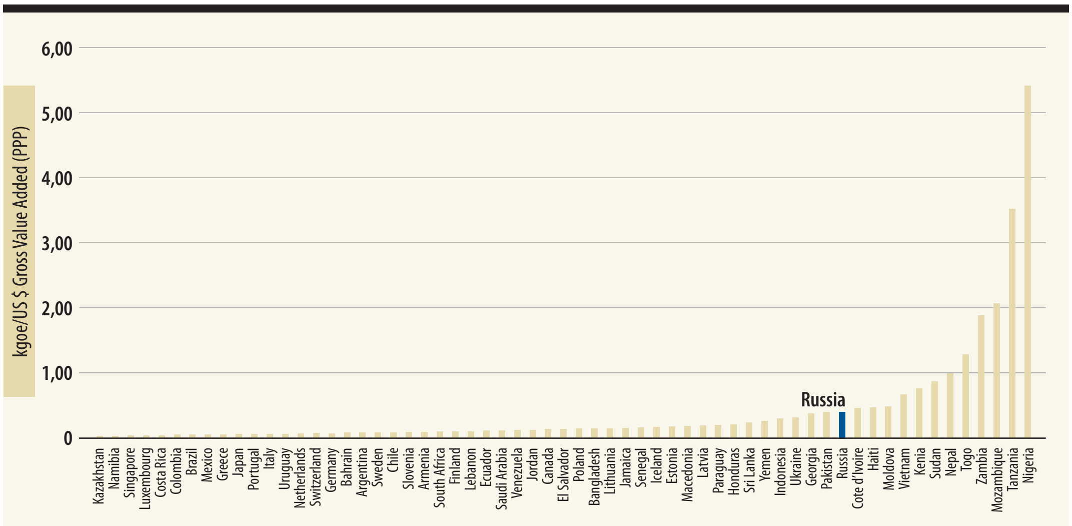
Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Figure 66: Comparison of Global Energy Intensities in Agriculture, Hunting and Fishing



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Figure 67: Comparison of Global Energy Intensity in Other Sectors



Source: Energy consumption data from the International Energy Agency (IEA), Energy Balances data set. Gross Value Added data from UNDP National Accounts data set. PPP conversion factor data from the World Bank Development Indicators Database.

Appendix B: Methodology for Estimating Potential for Energy Efficiency Gains in Russia

B.1 Estimating the Russian Energy Balance

An Integrated Fuel and Energy Balance (IFEB), estimated by CENEf serves as the foundation for the calculation of energy efficiency potential in this study. The IFEB for 2005 is shown below. The Russian IFEB format used in this paper is similar to the one used by the IEA (with some modifications), but accounting for the Russian energy statistics formats and specifics. The table below shows the IFEB for Russia.

Table B.1: Integrated Fuel and Energy Balance for Russia

	Coal	Crude oil	Petroleum products	Gas	Other solid fuels	Nuclear	Renewables	Electricity	Heat	Total
Production	**134.97**	**470.14**		**517.13**	**14.36**	**39.72**	**15.05**			**1191.37**
Import	11.05	2.38	0.28	6.22				0.87		20.80
Export	-39.23	-252.59	-97.10	-167.27				-1.94		-558.13
Stock changes	-1.26	0.07	0.77							-0.42
TPES	**105.52**	**220.00**	**-96.05**	**356.08**	**14.36**	**39.72**	**15.05**	**-1.06**		**653.62**
Statistical diff.		-7.10	-0.11	-2.00				-0.09	1.00	-8.30
Electricity generation	**-34.19**		**-3.73**	**-91.60**	**-3.35**	**-38.82**	**-15.05**	**81.98**		**-104.77**
Fossil fuels electricity plants	-21.28		-0.91	-45.61	-0.27			25.78		-42.29
CHP	-12.91		-2.46	-44.70	-3.07			27.36		-35.79
Diesel power			-0.36	-1.29	-0.01			0.43		-1.23
Other						-38.8	-15.1	28.4		-25.47
Heat generation	**-41.25**	**-0.79**	**-12.48**	**-129.40**	**-6.26**	**-0.90**		**-3.52**	**161.63**	**-32.97**
Fossil fuels electricity plants	-1.69		-0.07	-3.63	-0.02			-0.15	5.11	-0.46
CHP	-12.58		-2.39	-43.55	-2.99			-1.68	58.65	-4.55
Diesel power				-0.01	0.00	-0.90			0.30	-0.60
Industrial boilers	-13.99	-0.76	-6.95	-58.11	-2.04			-0.82	56.18	-26.48
District heating boilers	-3.12	-0.03	-1.22	-10.15	-0.11			-0.15	11.76	-3.03
Small boilers	-9.87		-1.85	-13.95	-1.10			-0.72	21.84	-5.64
Secondary heat utilization units									7.80	7.80
Fuel production and transform.	**-3.37**	**-211.80**	**200.49**	**-17.80**	**-0.42**	**0.00**	**0.00**	**-19.79**	**-32.53**	**-85.21**
Coal and peat production and transformation	-0.26	0.00	-0.17					-0.67	-0.73	-1.83
Oil production		-0.07	-0.37	-2.73				-4.09	-1.44	-8.69
Oil refinery	-0.10	-208.01	201.03	-7.61	-0.42			-0.89	-4.58	-20.60
Gas production and processing		-0.02		-4.56				-0.68	-1.54	-6.79
Own use								-3.76		-3.76
Distribution losses	-3.00	-3.71		-2.90				-9.69	-24.25	-43.54
TFC	**26.71**	**0.31**	**88.12**	**115.28**	**4.33**	**0.00**	**0.00**	**57.52**	**130.11**	**422.38**
Agriculture and forestry	**0.09**	**0.01**	**3.06**	**0.38**	**0.21**			**1.45**	**1.01**	**6.21**
Fishing	**0.00**		**0.00**	**0.01**	**0.00**			**0.0**		**0.04**
Mining	**0.00**	**0.02**	**0.92**	**0.00**	**0.00**			**2.40**	**3.85**	**7.19**
Manufacturing	**22.74**	**0.02**	**3.04**	**24.52**	**2.72**	**0.00**	**0.00**	**17.05**	**39.45**	**109.54**

	Coal	Crude oil	Petroleum products	Gas	Other solid fuels	Nuclear	Renewables	Electricity	Heat	Total
Coke	**2.53**		0.00	0.04				0.13	0.92	3.62
Oxygen								0.57	0.56	1.12
Compressed air	**0.05**		0.00	0.12				0.53	0.06	0.75
Water pumping and treatment for industrial use	**0.00**		0.01	0.02	0.00			1.68	0.11	1.82
Pig iron	**15.40**			3.87				0.06	0.22	19.55
Open hearth furnace steel			0.38	1.07	0.04			0.03	0.07	1.58
Basic oxygen furnace steel	**0.01**			0.19				0.12	0.03	0.35
EAF steel	**0.00**		0.00	0.23				0.72	0.06	1.01
Rolled steel	1.31		0.05	2.80				0.65	0.40	5.20
Steel pipes			0.00	0.49				0.13	0.10	0.72
Electroferroalloys	0.41			0.01	0.07			0.56	0.01	1.05
Synthetic ammonia				0.30				0.18	0.25	0.73
Furtilizers and carbamide			0.03	0.32				0.38	1.42	2.15
Synthetic caoutchouc			0.19	0.33				0.27	2.09	2.88
Casting and metal works	0.07	0.00	0.03	0.69	0.00			0.18	0.11	1.08
Pulp			0.07		2.41			0.31	2.16	4.96
Paper				0.00				0.38	0.80	1.18
Cardboard	0.00			0.00				0.17	0.59	0.76
Cement and clinker	0.47		0.06	4.62	0.00			0.55	0.02	5.72
Meat	0.00	0.00	0.01	0.03	0.00			0.11	0.33	0.48
Bread	0.04	0.00	0.03	0.39	0.04			0.10	0.23	0.84
Other manufacture	2.46	0.01	2.19	8.99	0.17			9.22	28.93	51.97
Construction	0.02	0.03	0.67	0.02	0.02			0.82	0.13	1.70
Transport and communication	0.21	0.00	52.75	33.16	0.01	0.00	0.00	6.82	1.44	94.40
Rail	0.20		2.85	0.03	0.01			3.88		6.97
Other	0.01	0.00	0.07	0.05	0.00			0.70	1.10	1.94
Oil pipelines		0.00	0.04	0.32				1.17	0.00	1.54
Gas pipelines				32.65				1.06	0.34	34.06
Water	0.00		0.87							0.87
Road			44.83	0.11						44.94
Aviation	0.00		4.09							4.09
Municipal utilities	0.01		0.06	0.02	0.00			1.80	1.72	3.61
Services sector	0.06	0.00	0.08	11.43	0.04			9.20	15.50	36.31
Residential	2.83		0.91	27.18	0.94			9.37	67.02	108.24
Non-specified	0.13	0.00	0.40	0.15	0.06					0.75
Non-energy use	0.65	0.20	26.15	18.41	0.32					45.73

Source: CENEf for the World Bank.

The table consists of three blocks: Energy resources, resource transformation in the energy sector, and energy end-use. The resources block includes primary energy production, export and import, and stock changes. The transformation block includes fuel balances of the power and heat sectors, energy resources of mining and extraction, oil refineries, coal enrichments, own energy use by energy sector, and distribution losses. The energy end-use block describes energy consumption by 35 end-use sectors and activities.

There are several standard forms in the Russian statistical reporting system available for the compilation of a database to piece together an energy balance for Russia:

- "11 TER" (fuel, heat, and power use);
- "6-TP" (heat and power plant operation);
- "1-TEP" (information on heat supply);
- "6-TP (hydro)" (data on hydropower plant operation);
- "6-TP (KES)" (data on electricity network operation);
- Electricity balance forms – "E-1", "E-2", and "E-3";
- "PE" (data on the operation of thermal power plants owned by non-industrial organizations);
- "4-fuel" (data on the fuel stock changes, fuel supply and consumption, waste petroleum products collection and use);
- "22 ZhKH" (data on utilities' performance during the reform period, also containing partial information on heat-, natural gas-, and power consumption);
- Forms on heat distribution systems' performance, which provide data on heat consumption and on fuel consumption by boiler-houses:
- Foreign energy trade data.

It should be noted that data from these different forms may be contradictory. Not all institutions are required to submit data for the entire set of forms. For example, Form "11 TER" is mandatory only for companies with annual fuel and energy consumption above two tce[123]. Therefore, some sources allow only for a basic, rather than a comprehensive, picture of energy use, and additional data and data verification are required. As another example: "11 TER" only reflects transportation heat losses in heat transmission lines, and continuously tends to underestimate losses in distribution systems which are reported in the form "1-TEP". In spite of its incompleteness, "11 TER" was used as the primary data source for the IFEB development. It serves as the basis for publicly available fuel consumption statistics and is used in the analysis.

B.2 Estimates of energy efficiency potential

Technical potential for energy efficiency improvements was estimated for this study by comparing the energy efficiency of equipment used in each energy consuming sector in Russia to the energy efficiency of equipment used in the same sectors elsewhere in the world. All equipment is categorized as shown in Box 5.26.

Box 5.26: Energy Efficiency Categories for Equipment

- **"Theoretical minimum"** – specific energy consumption required by thermodynamic laws to perform necessary work or material transformation.
- **"Practical minimum"** – the best practically achieved specific energy consumption worldwide with application of proven technologies.[124]
- **"Actual use abroad"** – average or the most wide spread specific energy consumption in other countries.
- **"Russian best"** – the best practically achieved specific energy consumption in Russia.
- **"Russian average"** – average specific energy consumption statistically observed and reported for Russia. It was used to assess the energy efficiency potential.
- **"Russian worst"** – the least energy efficient unit statistically observed and reported for Russia.

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123 1 toe = 1,43 tce.

124 Major most recent sources are: E. Worrell, M. Neelis, L. Price, et al. World best practice energy intensity values for selected industrial sectors. LBNL-62808. June 2007, and Energy Technology Perspectives 2006, Scenarios and Strategies to 2050. OECD/IEA. 2006.

Of the possible universe of energy efficiency investments with technical potential, only some will be financially and economically viable. This study differentiates between economically and financially viable projects in order to determine how Russia can best capture potential savings from energy efficiency investments. The difference between economically and financially viable investments is modeled by differentiating between: i) the opportunity cost of capital used for public and private investors, ii) the inclusion of indirect benefits of energy savings, and iii) the inclusion of externalities.

Economically and financially viable energy efficiency investments are those investments with technical potential which also yield a positive return on investment for Russian society as a whole, for private investors (companies, organizations, or individuals), or both. Economically viable projects yield a positive return on investment for Russia as a whole, and hence for the government as a public investor, but not necessarily for private investors, companies, or organizations. Financially viable projects yield a positive return for the private investors who make those investments.

Economically and financially viable investments are identified from the pool of technically viable investments by comparing the cost of an energy efficiency investment to the value of that investment. The "cost of saved energy" (CSE) approach is used to determine the cost of the energy efficiency investment. The costs of an energy efficiency investment include: i) the incremental capital cost of the energy efficiency investment, and ii) any additional costs or benefits of the energy efficiency investment. Box 5.27 shows the CSE formula and describes each variable in the formula.

Box 5.27: Cost of Saved Energy (CSE) Formula

The cost of saved energy (CSE) is an indicator of the cost of saving energy through a given type of energy efficiency investment. CSE is calculated by dividing the incremental (instead of full) cost of the energy efficiency investment by the energy savings the efficiency investment produces. CSE is expressed as:

$$CSE = \frac{CRF * CC + Cop}{ASE},$$

Where:

Cc = capital costs of the energy efficiency technology

Cop = the variation of current costs or if there are other costs associated with the energy efficiency investment (if there are additional savings as a result of the energy efficiency investment, for example, increased output or greater reliability, this component is negative)

ASE = annual savings of energy, expressed in terms of volumes of energy saved

CRF = capital recovery factor, which is calculated as follows:

$$CRF = \frac{dr}{1-(1+dr)^{-n}},$$

Where ***dr*** = the discount rate used by the party considering the energy efficiency investment.

The incremental capital costs (Cc) of an investment are estimated as the difference between the costs of i) an investment which improves energy efficiency to Actual Use Abroad or Practical Minimum (depending on the sector and available data on different types of technologies), and ii) a new investment with a level of energy efficiency comparable to that of equipment currently operating in Russia. Capital costs of different technologies were taken from a variety of sources cited in the main text of this report.

The capital cost of the energy efficiency investment must be weighted by a factor (the capital recovery factor or CRF) which specifies what percentage of the capital cost the investor is willing to bear during each year of the investment's useful life. The value of the CRF in turn depends on the investor's opportunity cost of capital; in other words, the highest return possible from alternative investments.

The additional costs or benefits (Cop) may include annual changes in operating and maintenance (O&M) costs, avoided capital costs, or externalities associated with a particular energy efficiency investment. Benefits are reflected as a negative cost in Cop of the CSE formula in Box 1.27). The total annual costs of the energy efficiency investment (CRF*Cc+Cop) are expressed in terms of a single unit of energy saved (for example, kWh of electricity or m^3 of gas). This is achieved by dividing the total annual costs of the energy efficiency investment by the total annual savings resulting from the investment.

The annual cost of saved energy (CSE) can be compared to the average energy price to determine whether the investment makes sense from an economic or financial perspective. If, for example, the CSE of installing energy efficient lighting is one Russian ruble/kWh, but the investor pays, on average is two Russian rubles/kWh for electricity, then the investment will yield a positive return and is (in the case of this example) financially viable.

Economic viability

As noted above, the difference between economically and financially viable investments is modeled by differentiating between: i) the opportunity cost of capital used for public and private investors, ii) the inclusion of indirect benefits of energy savings, and iii) the inclusion of externalities.

This study assumes a 6 percent opportunity cost of capital for public investors, lower than for private investors. Public investors, which may include governments, or possibly some nonprofits or community organizations, will have an interest in making investments which may produce lower returns but which yield benefits for society as a whole.

Economically viable investments are also distinguished from financially viable investments in that externalities (positive and negative) are included as part of additional costs (Cop). The largest externality considered in the sections that follow is the reduction in carbon dioxide (CO_2) which accompanies many energy efficiency investments. This model assumes that the energy savings achieved in some sectors could be sold as CO_2 reduction credits. The value of these credits is included as an offset (negative Cop) to the cost of saved energy, assuming a sale price of €10 (roughly $13.68) per ton of CO_2.

Finally, this study distinguished economically viable investments from financially viable investments by accounting for the indirect effects of end-use energy efficiency improvements. The estimates of energy efficiency savings in this chapter account for the fact that the volumes of energy saved by most energy efficiency investments include both direct and indirect savings. End-use consumption is directly reduced by an energy efficiency investment while primary energy consumption is indirectly reduced because less fuel is required to transform energy for end-use consumption. For example, a reduction in household electricity consumption reduces the volume of fuel generators must use to serve load. The less fuel generators burn, the less fuel that needs to be extracted and transported (whether by pipeline, rail, or road), and the less energy that needs to be spent extracting that fuel. A reduction in end-use electricity consumption also reduces the absolute volume of electricity transmission losses, as well as the volume of fuel lost in delivery to the generating station. The value of this "multiplier" was calculated from Russia's 2005 IFEB, using a method developed by CENEf. An explanation of this methodology is included in B.3.

Financial viability

Private actors will have a higher opportunity cost of capital, because their objective is driven largely by profit motivation. This study assumes a 12 percent opportunity cost of capital for private investors, and a 50 percent opportunity cost of capital for households (individual) investors. Households will have a still higher opportunity cost of capital for a number of reasons: they are typically more risk averse to making energy efficiency investments, they would need to borrow at retail lending rates in order to make any significant capital investment, or they have what they perceive to be higher value uses for their free cash.

This study further distinguishes financially viable projects from economically viable projects by excluding from the CSE calculation the value of any externalities or indirect energy efficiency savings. Private investors will undoubtedly make investments which have positive (and negative) externalities, and yield indirect energy savings, but the investor will not likely consider these factors important when deciding whether to invest in energy efficiency.

B.3 Evaluating the Direct and Indirect Effects of Improving End-Use Energy Efficiency

As discussed in B.2 above, the translation of final energy savings into saved primary energy requires that indirect effects of end-use energy efficiency improvements be evaluated throughout the entire energy supply chain. Data in the IFEB allow for the estimation of an intermediate energy consumption matrix (see Table B.2), followed by the calculation of an AE matrix (a square matrix of coefficients of primary energy carrier i to produce and deliver to end-user one unit of energy carrier j, see Table B.3), as well as a reverse (E-AE) -1 matrix (see Table B.4).

Table B.2 should be read: to produce and deliver to final users 160.74 mtoe of district heat, 41.25 mtoe of coal, 129.4 of natural gas, are needed throughout the whole energy sector, and 24.25 mtoe are heat losses. In the last case, for every one mtoe of district heat produced, 0.151 mtoe is lost, as shown by the coefficients in Table 7.3.

Table B.2: Intermediate energy consumption by Russian energy complex, 2005 (mtoe)

	Coal	Crude oil	Petroleum products	Gas	Other solid fuels	Electricity	Heat
Coal	-3.26		-0.10	0.00		-34.19	-41.25
Crude oil		-3.78	-0.07	-0.02		0.00	-0.79
Petroleum products	-0.17	-0.37	-2.81	0.00		-3.73	-12.48
Gas		-2.73	-7.61	-7.46		-91.60	-129.40
Other solid fuels			-0.42	0.00	0.00	-3.35	-6.26
Electricity	-0.67	-4.09	-0.89	-0.68		-13.45	-3.52
Heat	-0.73	-1.44	-4.58	-1.54			-24.25
Total primary or secondary energy production	**134.97**	**470.14**	**200.49**	**517.13**	**14.36**	**54.11***	**160.74***

* Nuclear and hydro electricity and heat are excluded

Source: Estimated by CENEf for the World Bank.

Table B.3: Direct coefficients of primary energy supply by energy complex per unit of energy production in 2005 (mtoe/mtoe)

	Coal	Crude oil	Petroleum products	Gas	Other solid fuels	Electricity	Heat
Coal	0.024	0.000	0.001	0.000	0.000	0.632	0.257
Crude oil	0.000	0.008	0.000	0.000	0.000	0.000	0.005
Petroleum products	0.001	0.001	0.014	0.000	0.000	0.069	0.078
Gas	0.000	0.006	0.038	0.014	0.000	1.693	0.805
Other solid fuels	0.000	0.000	0.002	0.000	0.000	0.062	0.039
Electricity	0.005	0.009	0.004	0.001	0.000	0.249	0.022
Heat	0.005	0.003	0.023	0.003	0.000	0.000	0.151

Source: Estimated by CENEf for the World Bank.

Table B.4: Full coefficients of primary energy supply by energy complex per unit of energy production in 2005 (mtoe/mtoe)

	Coal	Crude oil	Petroleum products	Gas	Other solid fuels	Electricity	Heat
Coal	1.03	0.01	0.01	0.00	0.00	0.87	0.34
Crude oil	0.00	1.01	0.00	0.00	0.00	0.00	0.01
Petroleum products	0.00	0.00	1.02	0.00	0.00	0.10	0.10
Gas	0.02	0.03	0.07	1.02	0.00	2.32	1.04
Other solid fuels	0.00	0.00	0.00	0.00	1.00	0.08	0.05
Electricity	0.01	0.01	0.01	0.00	0.00	1.34	0.04
Heat	0.01	0.00	0.03	0.00	0.00	0.02	1.19
Total	**1.07**	**1.07**	**1.14**	**1.03**	**1.00**	**4.73**	**2.75**
Total. including fuel transportation	**1.08**	**1.07**	**1.16**	**1.11**	**1.00**	**4.94**	**2.84**

Source: Estimated by CENEf for the World Bank.

To produce one toe of electricity, 1.69 toe of natural gas is needed; but to produce this gas, some additional energy (0.068 toe, including 1.69*0.001 toe of electricity and 1.69*0.003 toe of heat) is required to produce, so additional 0.11 toe of gas is needed. Evaluation of full coefficients of primary energy supply by the energy complex per unit of energy production allows it to express this endless chain of calculations through a single multiplier – the so-called full coefficient (Table B.4). The last two lines in Table B.4 show such multipliers and their composition for the assessment of integral effects of end-use efficiency improvements. These coefficients may be interpreted as follows: if end-users save one toe of petroleum products, the total energy need in the whole energy sector will decline by additional 0.14 toe (or 0.16 toe, if liquid fuel in transportation is accounted for[125]). The highest multipliers are for electricity and heat generation. They far exceed regular multipliers accounting only for the fuel efficiency of electricity generation (2.5 with 40 percent efficiency, or three with 67 percent generation transmission and distribution losses[126]) and heat generation (1.25 with 85 percent

[125] These estimates for multiplies are quite close to the ones assessed in 1992 for the FUSSR. See I. Bashmakov. Costs and benefits of CO_2 emission reduction in Russia. In Costs, Impacts, and Benefits of CO_2 Mitigation. Y. Kaya, N. Nakichenovich, W. Nordhouse, F. Toth Editors. IIASA. June 1993.

[126] Worrell, E., Neelis, M., Price, L., Galitsky, C., Zhou, N. World Best Practice Energy Intensity Values for Selected Industrial Sectors, 2007. Berkeley, CA: Lawrence Berkeley National Laboratory. 2007.

efficiency of heat generation and 5 percent heat losses). If one mtoe of electricity is saved in Russia the integrated primary energy savings throughout the whole energy supply chain are not 2.5-3 mtoe as usually calculated accounting only for power generation and electricity transmission and distribution efficiency in Western countries, but 4.7 mtoe (4.9 mtoe if fuel transport by railroads is accounted for).

To make the transition from the final to primary energy simpler for some applications, Table B.4 was reduces to a 3x3 matrix limited to fuels, electricity, and district heat (Table B.5).

Table B.5: Reduced form of full coefficients of primary energy supply by energy complex per unit of energy production in 2005 (mtoe/mtoe)

	Fuels	Electricity	Heat
Fuels	1.06	3.46	1.56
Electricity	0.01	1.36	0.05
Heat	0.01	0.03	1.19
Total	**1.07**	**4.84**	**2.80**
Total. including fuel transportation	**1.10**	**4.92**	**2.83**
Traditionally used coefficients	1.00	2.50-3.03	1-1.25

Source: Estimated by CENEf for the World Bank.

The coefficients presented above are used in the evaluation of technical and economic potential only, as private individuals or firms would have no way to recoup this savings and therefore do not base their decisions on its potential.

Appendix C: Measures to Improve Energy Efficiency

Table C.1: Measures to improve energy efficiency in Russia by impact, preparation time and incremental cost per unit.

Measure	Impact	Preparation time	Incremental cost per unit
PRE-REQUISITES FOR SUCCESS			
Establish a dedicated agency/function	high	under 1 year	low
Statistical data gathering	high	1-3 years	low
1.RESIDENTIAL			
Quick wins			
Launch an EE information dissemination campaign	high	1-3 years	low
Introduction of mandatory minimum requirements into standards on energy efficiency of buildings, keeping of energy passports to monitor energy efficiency throughout the period of use of building	high	under 1 year	medium
Essentials			
Require that energy efficiency improvements be made as a condition of government financial support for capital repairs	medium	under 1 year	medium
Provide incentives for more widespread metering	medium	1-3 years	low
Develop standardized performance-based management contracts for HOAs and building management companies	medium	1-3 years	low
Establish a capital repairs loan guarantee facility	medium	1-3 years	medium
Introduce energy efficiency standards and labeling for lighting and household appliances	low	1-3 years	low
2. PUBLIC ORGANIZATIONS			
Quick wins			
Allow more budget flexibility and extend budget planning periods	high	under 1 year	low
Develop regulations to allow for multi-year contracts and application of EE criteria for procurement	high	under 1 year	low
Essentials			
Autonomous status for public organizations	medium	1-3 years	low
Set targets based on benchmarking	medium	1-3 years	medium
Disseminate information on EE improvements	medium	under 1 year	low
3. INDUSTRY			
Quick wins			
Disseminate information on energy efficiency	high	under 1 year	low
Essentials			
Facilitate financing for EE investments through Russian financial institutions	medium/high	1-3 years	medium
Develop energy performance standards and labels for industrial equipment	high	1-3 years	medium
Introduce measures to reduce transaction costs	medium	1-3 years	medium
Fiscal incentives	high	1-3 years	high
Introduce taxation or cap-and-trade schemes for pollutants and/or emission	high	1-3 years	high
High cost, high return			
Complete electricity sector reforms, and initiate gas sector reforms	high	over 3 years	high

Measure	Impact	Preparation time	Incremental cost per unit
4. HEATING			
Quick wins			
Transform MUPs into commercial entities or private-public partnerships	high	1-3 years	low
Reform tariff methodologies	high	1-3 years	low
Essentials			
Develop and coordinate municipal heat supply development plans	medium	1-3 years	low
5. ELECTRICITY			
Quick wins			
Reform tariff-setting methodologies	high	1-3 years	low
Essentials			
Implement DSM/Rate payer funded energy efficiency programs	high	1-3 years	low
Clarify and standardize requirements and procedures for siting new generation plants and connecting to the grids	medium	over 3 years	low
High cost, high return			
Complete electricity sector reforms	high	over 3 years	high
6. TRANSPORT			
Essentials			
Encourage changes in behavior through information dissemination	medium	1-3 years	low
Reward drivers who opt for more energy efficient transport options	medium	under 1 year	medium
Introduce fuel efficiency labeling for new cars	low	under 1 year	low
Tighten fuel efficiency and emissions standards	high	under 1 year	high
High cost, high return			
Charge users the full cost of road usage	high	1-3 years	high
Take an integrated approach to transport planning	high	over 3 years	high
Offer better quality of service on public transport	high	over 3 years	high
Tax drivers for private vehicle usage	high	over 3 years	high
7. GAS FLARING			
Quick wins			
Improve monitoring and enforcement of utilization requirements, possibly through an independent regulatory body	high	under 1 year	low
Essentials			
Enact Federal legislation requiring APG utilization, including heavier fines and possible loss of operating licenses	high	1-3 years	high
Allow third-party access to Gazprom pipelines	high	1-3 years	high
High cost, high return			
Continue liberalization of gas prices	high	over 3 years	high

International Finance Corporation
Russian Country Office

Bolshaya Molchanovka 36-1
121069 Moscow, Russian Federation
Tel: +7 495 4117555
Fax: +7 495 4117572

www.ifc.org/russia/energyefficiency
rsefp@ifc.org

World Bank Russian Country Office
The World Bank (IBRD)

Bolshaya Molchanovka 36-1
121069 Moscow, Russian Federation
Tel: +7 495 745 7000
Fax: +7 495 745 7002

www.worldbank.org.ru
moscow@worldbank.org