McKinsey&Company




Pathways to an energy and carbon efficient Russia

Opportunities to increase energy efficiency and reduce greenhouse gas emissions

Summary of findings

ABOUT THIS STUDY

In autumn 2009, as part of its efforts to quantify energy efficiency and greenhouse gas abatement measures across major economies, McKinsey & Company conducted an independent and self-financed study on the related topics of increasing energy efficiency and reducing greenhouse gas emissions in Russia. The research team interacted with more than 50 experts, among them some of the leading specialists in Russia, and gratefully acknowledges their input.

This study does not assess science, policies or regulatory choices related to energy efficiency and greenhouse gas emissions. Rather, the purpose of the study is to identify opportunities in Russia to improve energy efficiency and reduce greenhouse gas emissions. The study focuses on quantifying and prioritizing these opportunities based on purely economic considerations, starting with those measures that would give the best economic return per unit of energy saved and per tonne of CO_2 equivalent (CO_2e) abated.

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1. Summary

RUSSIA HAS SIGNIFICANT OPPORTUNITIES TO IMPROVE ENERGY EFFICIENCY AND REDUCE CARBON EMISSIONS TO THE BENEFIT OF ITS ECONOMY

Energy efficiency now stands at the forefront of Russia's national agenda. To modernize, the Russian economy must find ways to grow more productively. In other words, it must generate more goods and services per worker employed (labor productivity), per ruble invested (capital productivity) and – a major focus of this report – per unit of energy consumed (energy efficiency).

At the same time, a closely related topic stands at the forefront of the global agenda: the reduction of greenhouse gas emissions, primarily CO_2. Russia could play an important role in contributing to the global effort to reduce emissions, on account of its physical size, the extent of its population, the energy-intensive structure of its economy, and its old and relatively inefficient production capacity.

As newer, more energy-efficient equipment and buildings replace older installations, Russia's GDP becomes less energy intensive. Taking this trend into account, we project that if Russia were to fulfill its aspiration of up to 6% per annum growth in GDP, which means the economy more than doubles by 2030, its energy consumption would increase by only 40%, to 1,325 million tonnes of coal equivalent (Mtce)[1] between 2005 and 2030. Its greenhouse gas emissions over the same period would also increase by only 40%, to 2,990 million tonnes of carbon dioxide equivalent (Mt CO_2e), leaving the country's overall emissions close to its benchmark 1990 emissions level. This anticipated development has been forecast as the "reference case", as it is based on natural growth patterns without any specific intervention.

As this report shows, however, Russia can go further by actively undertaking numerous measures to improve energy efficiency and reduce emissions without inhibiting its rapid growth. Not only is Russia blessed with highly diversified and self-sufficient energy resources, the country also has the potential to grow in an energy- and emissions-neutral way. In fact, Russia has the largest relative potential among all the BRIC countries to reduce emissions through implementing only measures that are economically attractive.

This study identifies 60 measures that could be implemented in order to enable Russia to achieve its economic growth aspirations with energy consumption and greenhouse gas emissions remaining at current levels. The measures identified in this report are not likely to happen without deliberate action. The program would require some €150 billion (bn) in investments over the next twenty years, but would bring savings of up to €345 bn over the same period. Compared with the levels projected for 2030 as per the reference case, these measures could reduce Russian energy consumption by 23% (to 1,020 Mtce) and greenhouse gas emissions by 19% (to 2,425 Mt CO_2e).

1 In this report, we adopt the standard Russian definition of tonne of coal equivalent as 7.0 Gigacalories, equivalent to 873m^3 of natural gas, 27.8 MMBtu, 0.7 toe.

The largest opportunities are in the following sectors:

- **Buildings and construction.** By implementing energy efficiency measures, Russia has the potential to save about 180 Mtce (13% of total energy consumption in 2030) and to cut emissions by 205 Mt CO_2e (7% of total emissions in 2030). Implementing these measures would require over €70 bn in investments, which would result in €190 bn in savings over twenty years.
- **Fuel and energy.** In the petroleum, gas, power and heat sectors, it is possible between now and 2030 to achieve more than €60 bn in savings through just over €20 bn in investments in energy efficiency measures. These measures would provide almost 80 Mtce of energy savings (6% of total consumption) and 160 Mt CO_2e of emissions reduction (5% of total emissions).
- **Industry and transport.** Although most energy efficiency gains in these sectors occur through natural replacement, there are additional opportunities for savings of about 50 Mtce (4% of total consumption) and a reduction of 200 Mt CO_2e (7% of total emissions). These measures require about €60 bn in investments and would bring €80 bn in savings over twenty years.

Agriculture and forestry offer an additional potential to reduce greenhouse gas emissions – and measures in these sectors are the least capital intensive ones. With investments of about €20 bn over the next twenty years, Russia could further reduce emissions by 340 Mt CO_2e, or 11% of its total reference-case emissions in 2030.

If Russia were to pursue fuel diversification – already a stated goal in the country's energy strategy – it could invest in nuclear energy, large hydro and renewable sources of energy. Whilst fuel diversification over the next twenty years would require high investments (€170 bn) relative to the cost saving potential (€20 bn), they would yield an additional abatement of 220 Mt CO_2e, or more than 7% of the total emissions in 2030.

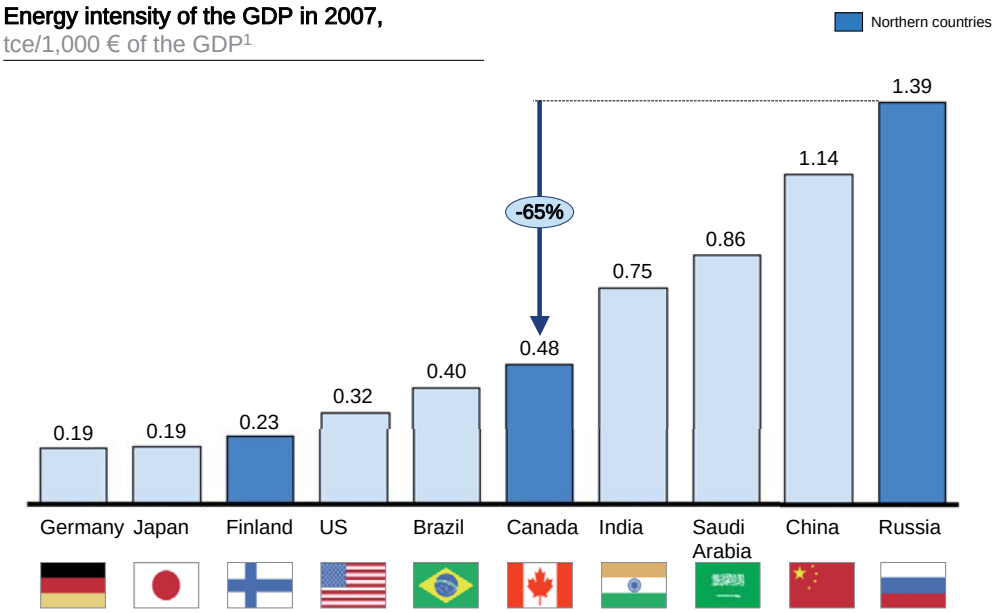
For these measures to be realized, a timely and targeted government effort would be required to support the private sector in overcoming the substantial existing barriers, such as high upfront investments, limited information, and misaligned incentives. Legislators are currently putting in place the necessary legal framework, but actually implementing the identified measures would require strong, coordinated action on the part of Russia's policy-makers. Such efforts could have a major impact on Russia's competitiveness and standard of living for many years to come.

2. Why does energy efficiency matter for Russia?

Today, for every €1,000 of GDP produced, Russia consumes 1.39 tce of primary energy, three times higher than Canada and more than any BRIC country (Exhibit 1). While climatic conditions and intrinsic economic factors contribute to this high level of energy intensity (Russia is a country of energy-heavy industries), the country's outdated and energy-wasteful equipment, buildings, and technological processes are also to blame. Meanwhile, inefficient energy use is a burden carried today by the Russian consumer.

Exhibit 1

Compared to other countries, Russia is the most energy-intensive



1 In 2005 prices

SOURCE: Rosstat; MED; BP Statistical Review of World Energy, McKinsey

Energy inefficiency affects Russian households, businesses and institutions. For example, most buildings lack thermostats, and so apartment-dwellers regulate temperature by opening their windows. Energy is also lost through the low levels of efficiency to be found in the cars and trucks on Russia's roads. Also, industrial engines do not economize on the power used in the case of reduced loads.

Inefficient energy use extends from the end-user all the way back to source: poor insulation of heating mains, gas leaks in pipelines, uneven pressure in the gas pipeline system, and power line losses all constitute losses of energy. The conversion process is also a source of energy loss, for example in outdated power plants that have low efficiency and are difficult to operate. Energy is also lost upstream, such as through the flaring of associated gas. Even cogeneration, an energy-efficient technology in which Russia has historically been a leader, is now in decline due to a drop in industrial steam demand and as a result of a series of organizational and regulatory challenges.

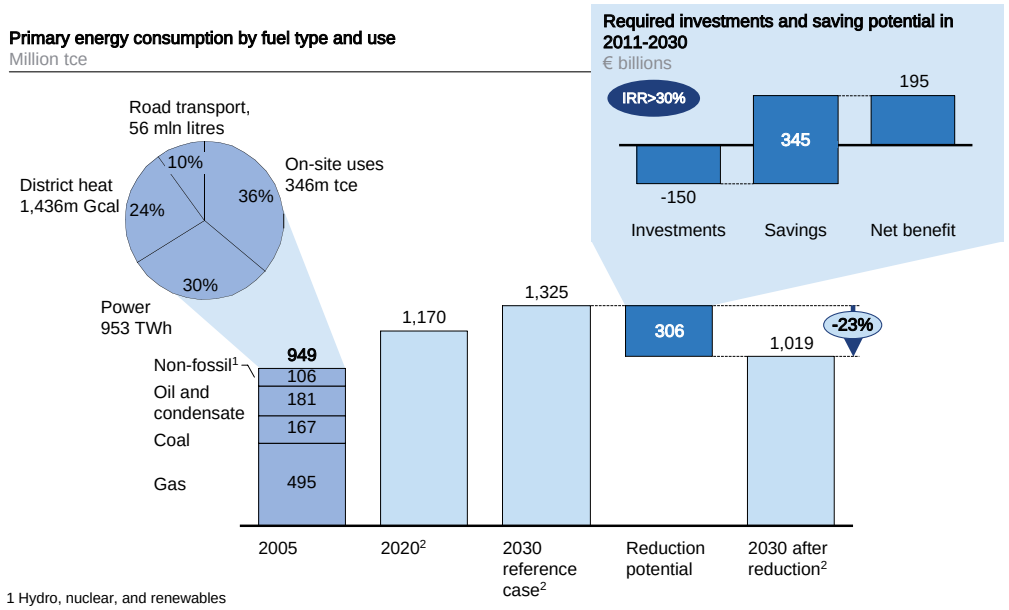
In all, economically attractive measures – overwhelmingly, these are energy efficiency measures – would require investments of up to €150 bn over the next two decades. These measures are value creating, with an average internal rate of return above 30%, contributing savings of €345 bn in the same timeframe (Exhibit 2), which is more than 1% of Russia's GDP over this period. A number of grounds make the case for implementing these measures compelling:

- **Russia could capture cost savings of more than €24 bn per year by 2030, which is 23% of the energy use, and more than 20% of overall national energy spend.** Increasing energy efficiency requires upfront investment, but would save costs over time through lower energy bills for both households and business. Industries that export goods have much to gain from increased energy efficiency, as by cutting overall production costs they become more competitive.
- **Russia could reduce its domestic consumption of fossil fuels by more than 20% and improve its trade balance.** Reducing domestic consumption of Russia's oil, gas, and coal could allow Russia to increase its exports of these products.
- **Russia could free up capital to invest in other sectors and diversify its economy.** Every ruble not used for energy consumption is available for spending on products in other sectors or for investing in new technologies.
- **Russia could reduce its greenhouse gas emissions by 19% compared to the reference case.** Energy efficiency translates into less fossil fuel burned and consequently means lower emissions of greenhouse gases, as well.

In short, energy efficiency provides an opportunity for Russia's economy to become less energy-dependent, while at the same time improving the environment. Although the required investments are significant, they bring with them economic benefits.

Exhibit 2

Russian primary energy consumption reduction and saving potential after implementation of economically attractive measures



1 Hydro, nuclear, and renewables
2 The structure of primary energy consumption in 2020-30 will depend on the future fuel mix in the Russian power sector

SOURCE: Rosstat; UNFCCC; McKinsey

3. What could global efforts to reduce greenhouse gas emissions mean for Russia?

Beyond the economically attractive energy efficiency measures, there are large opportunities to reduce emissions at net costs. In combination, these measures would require €410 bn over twenty years and would bring €90 bn in savings over the same period, reducing annual emissions by 900 Mt CO_2e as of 2030. Implementing just the least investment-intensive portion of these measures (agriculture and forestry measures) requires some €20 bn in investments and yields annual emissions reduction of 340 Mt CO_2e. Although such measures are not economically attractive on a stand-alone basis, there are reasons to consider them.

According to the assessments of the United Nations Intergovernmental Panel on Climate Change (IPCC),[2] it is necessary to quickly stabilize and to start reducing the concentration of greenhouse gases in the atmosphere to avoid severe ecological consequences, including flooding, water shortages, and reduced crop yields in many countries. These IPCC assessments are the basis for the Kyoto Protocol, which Russia signed in 2004.

Today, Russia emits 2,200 Mt CO_2e, which is less than 70% of the benchmark 1990 emissions level. Therefore, Russia is not under any obligation to take dedicated measures to reduce emissions under the Kyoto treaty. Nevertheless, decisions and investments made by other countries, among them the implementation of an emissions trading system in the European Union since 2005, have made greenhouse gas emissions reduction a business reality. Russia should consider the following benefits:

- **Russia could gain from participating in international emissions trading** as more than 1,045 Mt CO_2e (well over half of its abatement potential) comes either with some savings or at a cost of less than €20 per tonne of CO_2e (Exhibit 3), which is below the price per tonne of most market price projections in respect of "Assigned Amount Units" (AAU) of emissions reduction.
- **Russia could create up to 50,000 new jobs in agriculture and forestry.** Investing in measures to reduce greenhouse gas emissions would create new jobs in agriculture and forestry, and potentially also in innovative "green" industries.
- **Russia could enhance the competitiveness of its key sectors.** Investments to improve energy and carbon efficiency could improve Russian competitiveness. Also, by participating in greenhouse gas abatement efforts Russia could avoid any CO_2-related trade restrictions that could potentially be imposed by its main trading partners on non-participating nations.

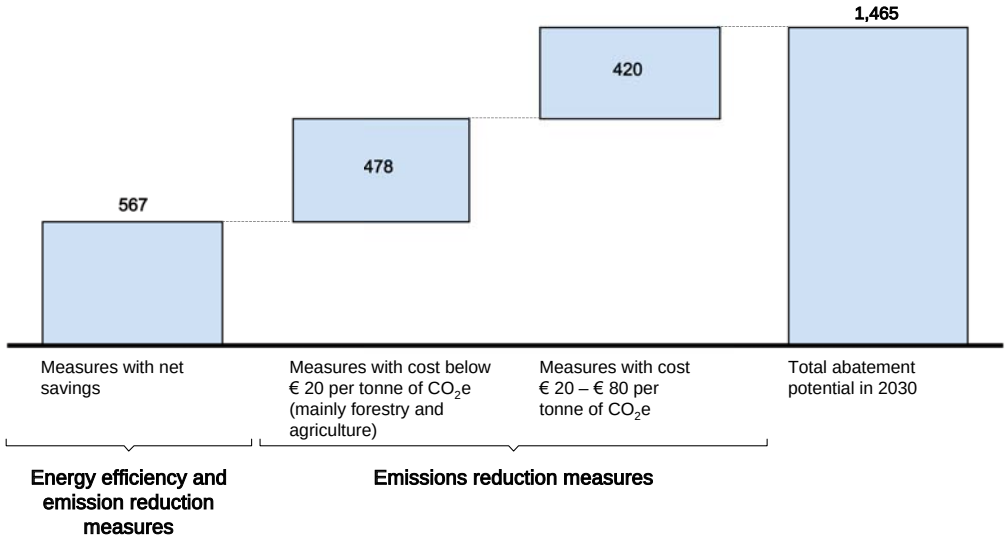
In short, even though investments in greenhouse gas emissions reduction (above and beyond energy efficiency) are not economically attractive on a stand-alone basis, Russia should consider them due to the broader, secondary economic benefits they bring.

2 This report, and McKinsey & Company generally, does not advocate a point of view on the science or politics of the question, but seeks instead to provide a fact base to assist decision-makers who are evaluating opportunities to reduce energy consumption and greenhouse gas emissions.

Exhibit 3

Greenhouse gas emissions abatement potential in 2030

Mt CO_2e



SOURCE: McKinsey

4. What could Russia be doing to achieve energy efficiency and reduce emissions?

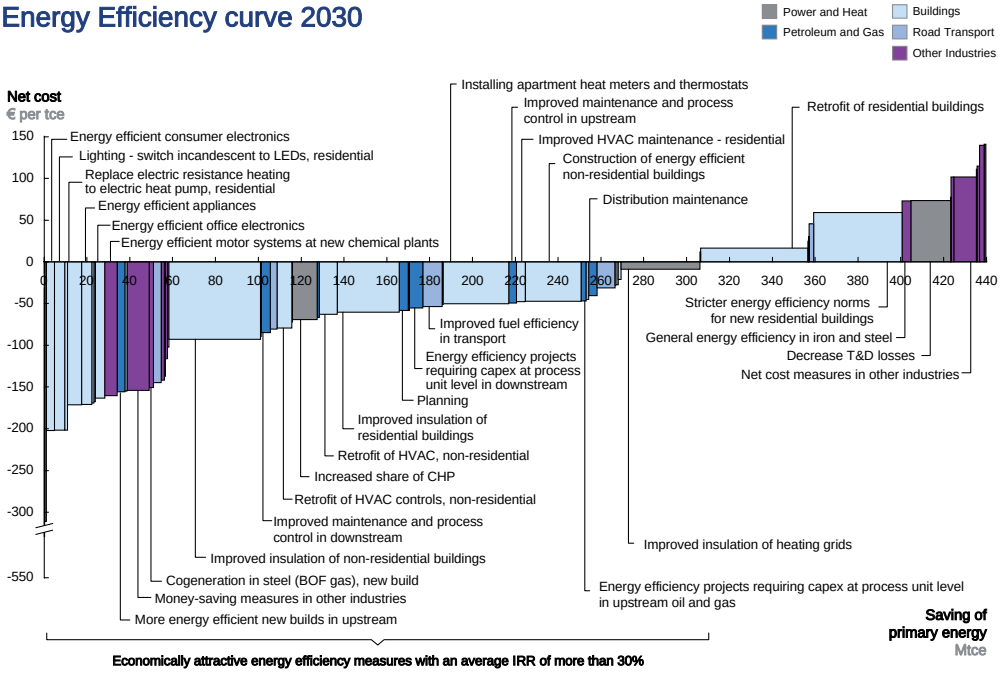
We reviewed more than 150 measures to identify the most significant opportunities for saving energy and reducing greenhouse gas emissions in Russia. We reviewed and prioritized measures purely on the basis of their economic attractiveness – for example, the potential energy reduction volume compared to the costs or savings obtained. Decision-makers will also need to take other considerations into account, such as the ease of implementation, job creation, or the desire to promote specific, strategic industries. Assessing these other considerations is not part of this study.

Broadly, two major types of measures are available for Russia:

- **Improvements in energy efficiency that also reduce greenhouse gas emissions. Based on our analysis, some 60 measures requiring investments of €150 bn would be economically attractive to investors with an average IRR above 30%.** These include the construction of more efficient power plants, reducing losses throughout the whole production chain, introducing more energy-efficient equipment in industry and in the home, and making energy efficiency improvements to buildings. Exhibit 4 shows energy efficiency measures, with the volume of energy (in tce) that could be saved for 2030 on the X axis, set against the costs of these measures for 2030 on the Y axis (in € per tce). Since most measures save money, such savings are portrayed on the Y axis as "negative costs".

Exhibit 4

Energy Efficiency curve 2030



SOURCE: McKinsey

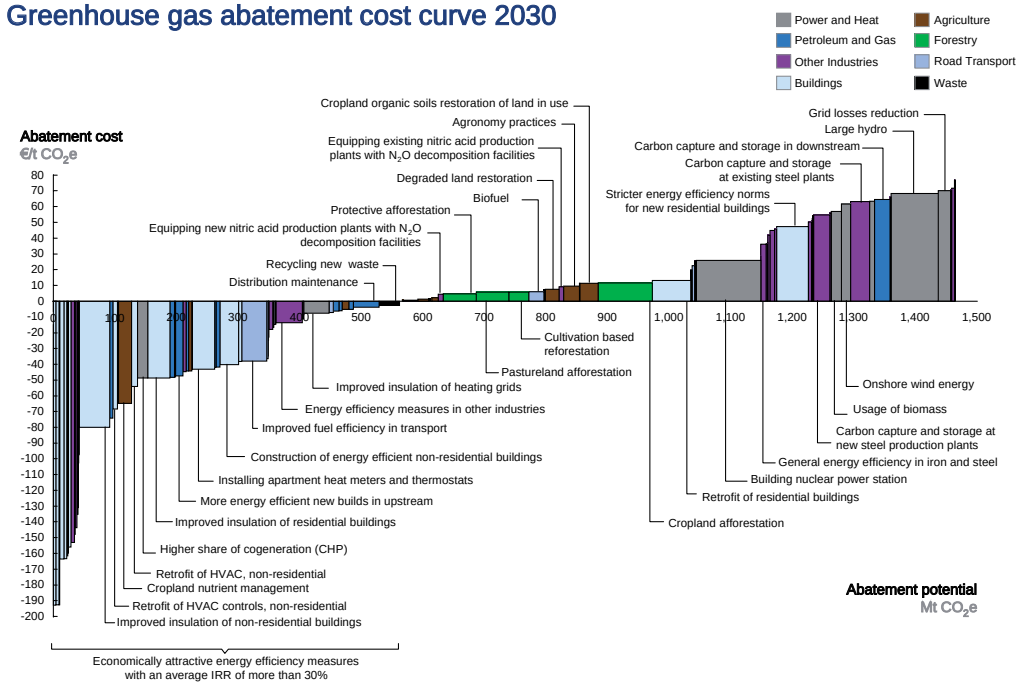
- **Measures to reduce greenhouse gas emissions.** These measures fall into several groups: investments in the **agriculture and forestry** sectors to create carbon sinks to absorb CO_2; changes to the national power generation **fuel mix** by constructing nuclear, hydro and renewable energy facilities; industrial **process changes**; and building industrial **carbon capture and storage** facilities. **These measures require some €410 bn of investments, which on a stand-alone basis are not directly economically**

attractive to private investors. Exhibit 5 shows all measures that abate greenhouse gas emissions (in Mt CO_2e), with the volume of abatement for 2030 on the X axis and the cost for 2030 on the Y axis. Here again, when measures save money, such savings are portrayed on the Y axis (in € per tCO_2e) as "negative costs".

These two types of measures will now be considered in more detail.

Exhibit 5

Greenhouse gas abatement cost curve 2030



SOURCE: McKinsey

4.1 Investments in energy efficiency that save money and also reduce emissions

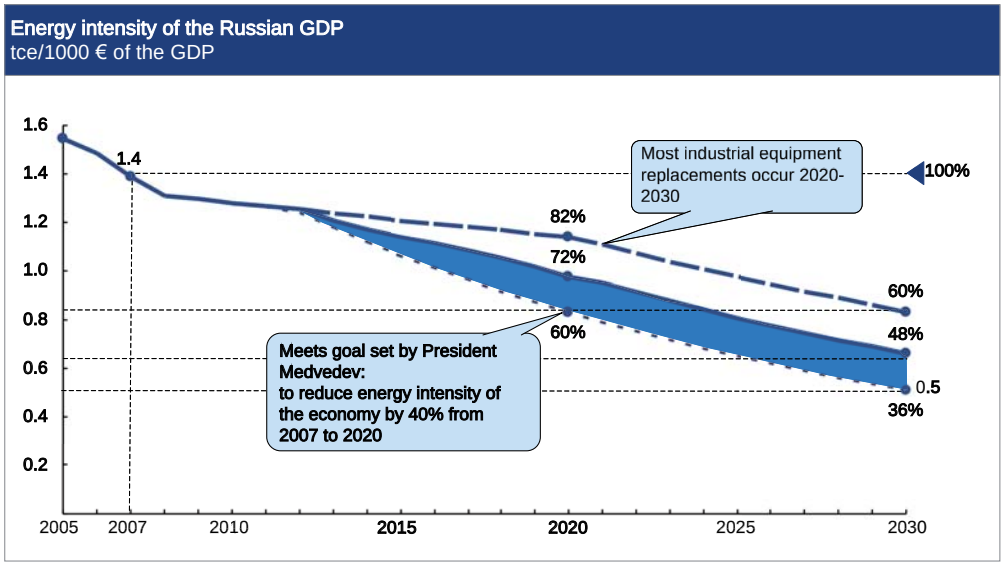
Even without any specific action, the energy intensity of Russian GDP is likely to decrease due to the natural improvement in energy efficiency. Compared to the 2007 level, the energy intensity of Russia's GDP is expected to fall by 18% as of 2020 and 40% as of 2030 (Exhibit 6). Additional potential for decreasing energy intensity by another 10% lies in structural changes in the economy, a topic outside the scope of this report.

A systematic program to increase energy efficiency can **keep Russia's energy consumption at today's level** even while the economy doubles in size. The amount of energy thus saved (306 Mtce per year in 2030, or 23% of total reference-case energy consumption in 2030) would be more than the total annual consumption of energy in Canada today (293 Mtce in 2007). At current prices this energy saving would be worth about €24 bn per annum. Thus, by implementing energy efficiency measures, Russia could cause its energy intensity to fall by a further 12%. In other words, energy intensity of the Russian economy could be as low as 0.51 tce/€1,000 as of 2030, in real terms.

Only by succeeding both with energy efficiency measures and with economic diversification will it be possible to meet President Medvedev's ambitious goal of a 40% reduction in energy intensity from 2007 to 2020.

Exhibit 6

Energy intensity of the Russian GDP



SOURCE: Rosstat; MED; McKinsey

Based on our analysis, some 60 measures are economically attractive on an overall national level, with an internal rate of return of more than 30%. The resulting benefits and savings exceed investment costs by almost €195 bn through 2030, or almost €10 bn per year.

The main economically attractive energy efficiency measures for Russia are concentrated in three areas: 1) buildings and construction; 2) fuel and energy; and 3) industry and transport (Exhibit 7). Below are the key opportunities in each of these areas:

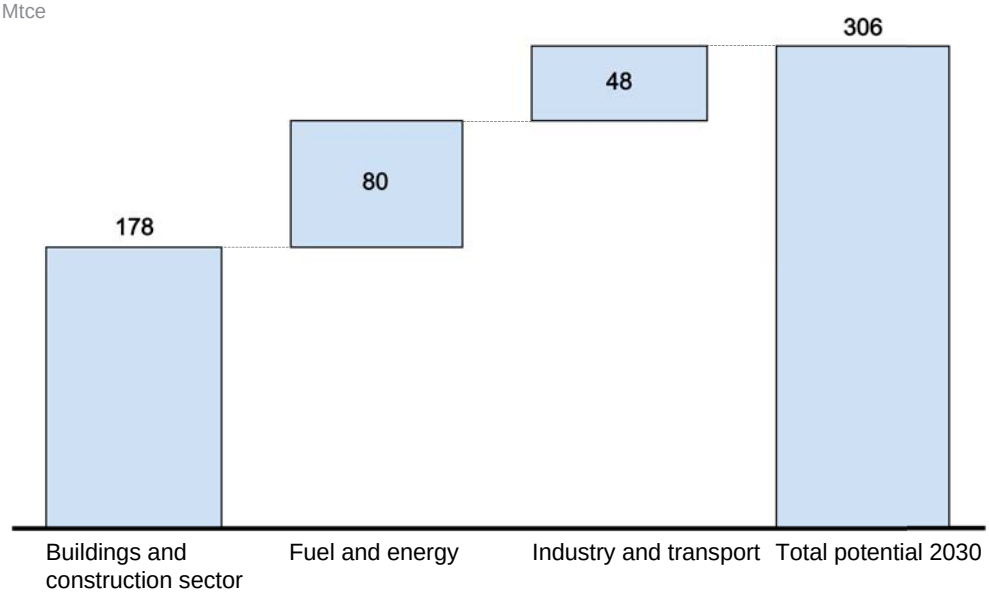
- **Buildings and construction.** Russia has the potential to save about 180 Mtce (13% of total energy consumption) annually as of 2030 in the building sector. The well-known energy efficient light bulbs are an example of an attractive measure with low investments and relatively fast payback, but it only captures about 2% of Russia's total energy reduction potential. Another key measure is the installation of thermostats and heat meters. Experience around the world shows that using thermostats in apartments to regulate heat levels and installing meters at least in individual houses could save 20% of the residents' heating bills by permitting residents to pay only for the amount of heat actually consumed on-site. Basic insulation measures (sealing baseboards and other places where air leaks, adding weather-strips to doors and windows, additional insulation for attics and wall cavities, etc.) save another 20%. Together, thermostats and insulation imply a saving of 600 rubles per family per month.[3]
- **Fuel and energy.** Measures in the petroleum, gas, power and heat sectors can save almost 80 Mtce annually (6% of total energy consumption). Key opportunities are in improved maintenance, leakage reduction and more even operation of the gas delivery system; in reducing internal consumption within power plants; and in decreasing losses in heating mains.

3 For a family living in a 60m^2 apartment and paying 1500 rubles for heating per month.

Exhibit 7

Energy reduction potential by implementing energy efficient measures in 2030 by sector

Mtce



SOURCE: McKinsey

- **Industry and transport.** Opportunities here amount to about 50 Mtce annually (4% of total energy consumption) over and above the measures that occur due to natural replacement of industrial stock. Energy saving and greenhouse gas abatement in industry do not mean additional costs. On the contrary, in many cases Russian companies could increase their competitiveness by becoming more energy efficient. For example, steel players could reduce their energy consumption by up to 6% by reusing the gas that is emitted in basic oxygen furnaces for power and heat production. For the economy as a whole, we estimate that the overall savings possible over the next two decades from implementing industry efficiency measures could reach more than €80 bn, from investments of €60 bn.

Implementing energy efficiency measures would also have a positive effect on reducing greenhouse gas emissions – some 570 Mt CO_2e per year would be eliminated as of 2030 (19% of total emissions). That means that despite the economy growing at up to 6% per year, Russia's emissions would only rise to 2,425 Mt by 2030 as against today's level of about 2,200 Mt CO_2e per year (still 25% below the 1990 benchmark level).

Required investments are unevenly distributed over the period, with more than €100 bn needed after 2020, mainly due to the fact that implementation of most transport measures is expected to start only after 2016. High savings potential in the final period is explained by the cumulative effect of the investments made over the previous fifteen years, mainly from measures in the building sector (Exhibit 8).

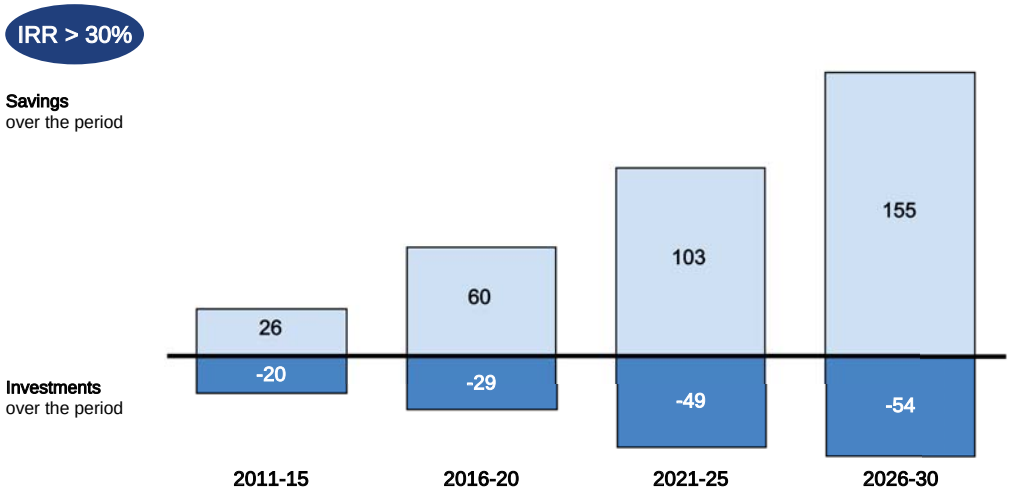
The energy saving potential is only moderately sensitive to changes in energy prices and costs of capital. An increase in the cost of capital from 8% plus inflation (overall national perspective) to 12% plus inflation (decision-maker perspective) would reduce the net-savings potential by only 8 Mtce and 18 Mt CO_2e (0.6% of projected 2030 national consumption and emissions). An increase in energy prices (from $60 to $90/bbl of oil), paired with a 40% increase in power and heat tariffs, would increase the energy saving potential from 306 to 359 Mtce, a 17% increase, and the net-savings abatement potential

from 570 to 650 Mt, an almost 15% increase. If applied together, increased energy prices and cost of capital would cancel each other out.

Exhibit 8

Economics of the implementation of energy efficiency measures over the period from 2011 to 2030 and resulting savings

€ billions



SOURCE: McKinsey

4.2 Measures to reduce greenhouse gas emissions

Our study identified 56 measures whose principal purpose is to reduce greenhouse gas emissions (Exhibit 9). We evaluated the cost-benefit relationship of these measures and developed a relative cost curve for these measures for Russia. Implementation requires around €410 bn in investments, with savings of €90 bn. These measures, which are not economically attractive on a stand-alone basis, could be grouped into three main categories, as follows:

- **Agriculture and forestry sector investments.** These measures are among the lowest-cost in terms of investments (€20 bn overall) and cost less than €10 per tonne of CO_2e abated. They could create about 50,000 jobs and offer an annual saving potential of 340 Mt CO_2e by 2030 (11% of total emissions), provided that an international verification system is put in place. Examples of such measures are: restoring organic soils and forests, as these absorb more carbon than they emit; and reducing or improving the use of fertilizers. Together these measures would make up about 23% of Russia's overall potential for abatement in 2030.

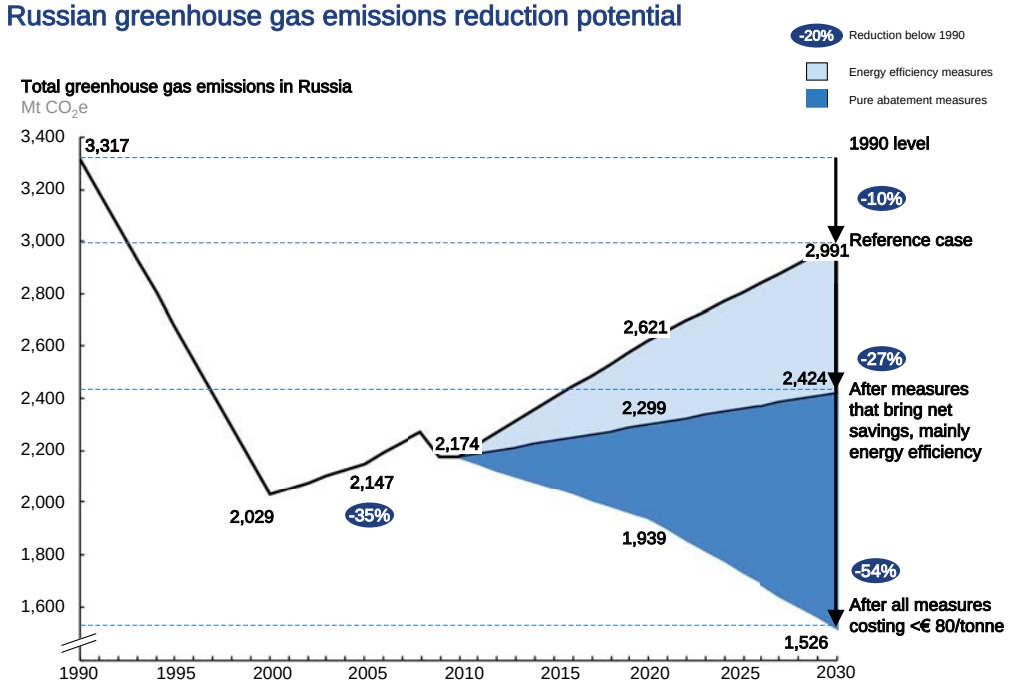
- **Fuel mix changes in the power and heat sector.** Increasing the capacity of nuclear plants (by 50-60 GW) and hydro generation (by 40 GW), as is envisaged in Russia's 2009 energy strategy, would potentially reduce emissions by up to 220 Mt CO_2e annually as of 2030 (7% of total emissions). These measures would reduce the carbon intensity of Russian power and heat generation in 2030 by 28% as compared to a scenario that uses natural gas generation. However, such measures require investments of more than €60 bn (nuclear) and more than €80 bn (large hydro), with an abatement cost of €26 and €68 per tonne of CO_2e abated in 2030, respectively.

- **Other measures.** Most remaining measures would require investments of €40 per tonne of CO_2e abated, or higher, and would offer an annual saving potential of about 335 Mt CO_2e (11% of total emissions) and 134 Mtce in 2030. These include: capital-intensive energy efficiency measures, which do not pay back at expected energy prices; changes in industrial processes; fuel mix changes in industry and transportation; and, if they become technologically proven, carbon capture and storage technologies. Implementation of these measures could be stimulated by some sort of subsidy or an effective carbon price in Russia.

Pursuing some or all emissions reduction measures could accrue a number of secondary benefits (new jobs, access to investments and technologies, and so on). In particular, Russia is uniquely positioned to pursue both agriculture and fuel mix measures because of its vast landmass, access to available hydro resources, and fully developed nuclear fuel cycle.

Exhibit 9

Russian greenhouse gas emissions reduction potential



SOURCE: UNFCCC, McKinsey

5. Timely action is needed to support implementation

The measures described in this report are unlikely to be implemented without explicit support from policy-makers. Even those opportunities to increase energy efficiency that are economically beneficial (i.e., where savings would exceed the amounts invested), are unlikely to happen if left to the private sector alone. Significant upfront investment requirements are only one barrier for private sector players. There are others that also need to be addressed.

While changes to the national fuel mix, for example, could be implemented by a limited group of decision-makers, millions of Russians would need to be involved in household decisions such as switching light bulbs or insulating their buildings, and an entirely new type of business – energy service companies – would have to emerge to capture some of the opportunities. Such measures would potentially touch about fifteen thousand multifamily, residential homes, or 4.5% of the national housing stock, each year. The overall implementation effort would create about 100 thousand permanent and seasonal jobs, including the mobilization of 50 thousand people for forestation efforts in rural and agricultural areas.

Therefore, in line with the examples from many countries around the world, Russian policy-makers should consider setting up numerous programs to address the barriers to implementing energy efficiency and abatement measures:

- **Incentives to ease upfront investments.** In total, some €150 bn is needed over the 2010-2030 period to implement economically attractive measures that improve both energy efficiency and reduce greenhouse gas emissions. Consumers tend to be reluctant to invest in energy efficiency improvements where the payback period exceeds one or two years; and in Russia, more often than in Western countries, businesses also tend to refrain from high investments with long payback periods as a result of higher market and economic uncertainties. Therefore, energy efficiency measures could be promoted through targeted loan programs that create the necessary incentives.
- **Building awareness and providing information.** Measures in agriculture and in residential buildings, where actors are widely dispersed, would be stimulated by additional investment to educate consumers about existing money-saving opportunities. In many countries around the world, governments are investing in creating more awareness of the importance of saving energy, and in educating the public on the economics of such investments.
- **Correcting market imperfections.** Companies' inefficiencies, for example in failing to control gas distribution leakages, are currently fully passed on to consumers. Installing metering devices could create the right incentives for companies to reduce leakages and losses in their distribution networks. Another example is the current tariff system, which in many locations is subsidized, so that tenants have insufficient incentives to act alone. Here, government can foster holistic solutions that spread the benefits among tenants, building managers, and energy companies.
- **Setting standards.** Developers are often not interested in investing in expensive energy saving technologies and instead tend to prefer low-cost solutions. To address this, stricter regulations and enforcement could be introduced. For example, in some countries governments have introduced building codes that dictate insulation, HVAC controls, windows, lighting, and appliance standards. In some countries developers are required to use state-of-the-art construction materials that provide energy savings.
- **Accounting for emissions abatement.** To get credits for emissions reduction it is necessary to create a robust international system that could track forestation and agriculture measures. It would benefit Russia to contribute to the establishment of such a system, as it would allow Russia to take credit, for example, for the carbon sinks that forestation opportunities in the country provide.

To seize the energy saving and emissions reduction opportunities that are available to Russia, timely action is critical. Delaying implementation by only five years would reduce the cumulative benefit for Russia by almost half, in both energy consumption and emissions reduction. Therefore, Russian policy-makers should not delay in taking strong, coordinated, and economy-wide action that will positively benefit Russia's economic competitiveness and standard of living for many years to come.

For more information, please contact **Stephan Solzhenitsyn** or **Karsten Schneiker** at moscow@mckinsey.com

This report exists in an English and a Russian version. Certain minor differences and discrepancies between the two versions may exist.

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