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Reducing black carbon emissions from diesel vehicles in Russia: An assessment and policy recommendations

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ABSTRACT

The paper assesses options and challenges of reducing black carbon emissions from diesel vehicles in Russia. Black carbon is a product of incomplete diesel combustion and is a component of fine particulate matter. Particulate matter emissions have adverse health impacts, causing cardiopulmonary disease and lung cancer; black carbon is also a large climate forcer. Black carbon emissions from Russian diesel sources affect not only the Russian territory but also contribute to overall pollution. This paper analyzes current ecological standards for vehicles and fuel, evaluates policies for emission reductions from existing diesel vehicle fleet, and assesses Russia's attempts to encourage the use of natural gas as a vehicle fuel. Based on best practices of black carbon emission reductions, this paper provides a number of policy recommendations for Russia.

1. Introduction

Diesel is growing as a fuel for on-road transport and off-road vehicles and equipment. Diesel vehicles are a source of black carbon (BC) emissions, a light-absorbing component of particulate matter (PM). Chronic exposure to particulate matter is associated with a range of diseases, as well as premature death from cardiopulmonary disease and lung cancer. According to a World Health Organization study, exposure to $PM_{2.5}$ reduces the life expectancy of the population in Eastern Europe by about 8.6 months on average (WHO, 2013).

The Intergovernmental Panel on Climate Change defined BC as a major contributor to global warming, with the third largest global warming potential after carbon dioxide and methane (Stocker et al., 2013). A recent study indicates that BC might be the second most powerful climate forcer after carbon dioxide (Bond et al., 2013).

BC has a particularly pronounced impact as a climate forcer in the Arctic. By darkening the surface of snow and ice and reducing its albedo, BC facilitates the absorption of solar radiation, increases air temperatures and accelerates snow and ice melting (EPA, 2012b; Flanner and Zender, 2006; Flanner et al., 2007). These effects make the Arctic an exceptionally vulnerable region for BC emissions (Hirdman et al., 2010); the Arctic is warming considerably faster than other regions of the globe.

Russia makes up a large part of the Arctic. While some BC is produced in the Arctic region by local diesel sources, most emissions are transported to the region from other parts of the country. Thus, it is important to analyze nation-wide policies and mechanisms for BC emission reductions.

The first detailed BC emission inventory from diesel sources for the most populous Arctic region of the Russian Federation was completed only recently (Evans et al., 2015). This study examines the main sources of BC emissions including on-road and off-road vehicles, fishing vessels and diesel generators. The study laid a foundation for developing policy recommendations to reduce BC emissions from diesel sources in Russia.

Diesel transport is a significant source of BC emissions in Russia. In 2000, 9% of total BC emissions in Russia came from transport. Transport is the fourth biggest source of BC emissions after residential/domestic sources, forest fires and industry (EPA, 2012b; Lamarque et al., 2010). Policymakers often focus on emission reductions from on-road transport because transport is one of the largest sources of emissions in cities. Off-road vehicles are also an important source of diesel emissions, but in Russia they represent only about 13% of total diesel-related BC emissions, compared to 49% that come from on-road vehicles. This is despite the fact that Russia currently has no regulations limiting off-road emissions, while the majority of the on-road fleet has some level of controls today.

The United States and the EU used a system approach to reduce diesel BC emissions (ICCT, 2009; NRDC, 2014; World Bank, 2014). This approach for transport-emission reductions focuses on three

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areas. First, low-sulfur fuel must be available to enable the use of retrofit technologies. Second, vehicle emission standards must be adopted and enforced for new vehicles entering the market. Third, the government should develop complementary strategies focusing on retrofits of older engines, inspections to identify and address super-emitters, procurement of new diesel vehicles and other programs aimed at reducing emissions from the existing diesel fleet.

While Russia faces many challenges in reducing vehicular emissions due to political, economic, and technological constraints, the country has a significant potential for BC reductions which would bring benefits to Russian people and the environment, both locally and globally. In fact, Russia has already shown much progress in reducing emissions because of vehicle and fuel standards.

This paper analyzes current Russian efforts aimed at reducing emissions from diesel vehicles. Russia, like other nations, does not directly regulate BC emissions but policies and programs aimed at reducing diesel exhaust emissions would also reduce BC.

2. BC emissions from diesel sources in Russia

2.1. Current ecological standards for vehicles and diesel fuel quality in Russia

On-road transport is traditionally the largest contributor to diesel particulate emissions around the world. Organisation for Economic Co-operation and Development (OECD) countries first implemented vehicle-emission standards in the early 1990s. The European countries initially introduced emission standards for on-road vehicles developed by the United Nations Economic Commission for Europe (UNECE) and then the EU developed its own standards. The main reason for introducing emissions standards were health concerns because vehicular emissions have adverse health impacts. Implementing emission standards is the most effective way to reduce emissions.

Russia adopted UNECE emission standards in 2006, which now apply to both domestically produced and imported cars. Before that, Russia did not have any emission regulations for on-road vehicles and leapfrogged to Euro 2/II standards (Table 1). (According to the common approach, standards for light-duty vehicles are expressed by using Arabic numerals while Roman numerals are used for heavy-duty vehicles.)

The availability and widespread use of ultra-low-sulfur fuel is a critical prerequisite to control BC emissions. Emission reductions require high-quality fuel that enables advanced emission-control technologies.

Recently, Russia has rapidly increased production of ultra-low-sulfur diesel (Euro 5). Euro 5 diesel (with sulfur content of 10 ppm) accounted for 17% of Russia's total domestic diesel market production in 2011, compared to 29% in 2012, and 52% in 2013 (Novak, 2014). This progress was a result of regulation, bolstered by well-targeted fiscal policy. Russia introduced an excise tax on diesel fuel in 2011 to force diesel producers to move from low-quality to high-quality fuel.

Table 1
Introduction of emission standards for on-road vehicles in Russia.

	Euro 2/II	Euro 3/III	Euro 4/IV	Euro 5/V
Light-duty vehicle	April 2006	January 2008	January 2014	January 2016
Heavy-duty engines	January 2006	January 2008	January 2013	January 2016

Compliance and enforcement measures aimed at ensuring the use of high-quality diesel are fundamental for emission reductions. Though Russia made significant progress in modernizing its major refineries, some small refineries still can produce low-quality diesel. Rostekhnadzor, the supervisory body of the Government of Russia on ecological, technological, and nuclear issues, is responsible for fuel quality control. All small refineries checked by Rostekhnadzor in 2011–2012, produced diesel which did not meet the minimum standards. In 2013, 33.7% of fueling stations sold diesel that did not meet the Euro 3 requirements. One of the reasons why poor quality diesel is still available at fueling stations is because technical regulation does not regulate all stages of production and distribution. Rostekhnadzor can inspect refineries only once in three years and is required to inform about inspections in advance. Any unplanned inspection must be approved by local law enforcement. The government should introduce rigorous control over fuel quality at fueling stations and use financial penalties to those who sell diesel that does not meet minimum standards.

2.2. Russia's on-road diesel fleet

There are three distinct trends in the development of on-road transport in Russia. First, the total number of vehicles on the roads is growing rapidly. Between 2000 and 2013, the number of passenger cars doubled, while truck and bus fleets increased by about 40% (Table 2). There were about 48 million vehicles in Russia in 2013. Private-car ownership will likely continue to grow as personal car ownership remains far below levels in most developed countries. There were 273 cars per 1000 people in Russia in 2013, while there are 500–700 vehicles per 1000 people in OECD countries.

Second, diesel vehicles have become more popular in Russia (Table 3). The growing diesel fleet means that more sources of BC emissions are on the roads now. In 2012, the share of diesel cars in the existing fleet was 4%, while it was 6% in new vehicle sales (Avtostat, 2013). However, the share of diesel cars might be much higher in some regions; for example Evans et al. found that the share of diesel cars in city of Murmansk in the Arctic was 12% (2015). Increasing popularity of diesel engines in Russia is in line with the same trend in Europe, where the car fleet has been persistently transformed from being petrol-driven to diesel-driven over the last 20 years (Cames and Helmers, 2013).

Finally, while the share of newer vehicles is growing, the share of vehicles older than 10 years is stagnant (Table 4). However, the stagnant share of older vehicles might be a result of outdated information, when old vehicles are not being used but remain on the registries.

The Russian government recognizes the problem of air pollution from transport. The government wants to modernize

Table 2
On-road vehicle fleet, 2014, in thousands.

	2000	2005	2010	2011	2012	2013
Cars	20,353	25,570	34,354	36,415	38,792	41,428
Trucks	4401	4848	5414	5545	5751	6050
Buses	640	792	894	902	928	891

Source: Rosstat (2014).

Table 3
The share of diesel vehicles in the Russian bus and truck fleet, %.

	2010	2011	2012	2013
Buses	35.7	38.3	41.1	43.3
Trucks	46.6	49.1	53.2	55.8

Source: MNRE (2013).