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CLEANING UP THE GLOBAL ON-ROAD DIESEL FLEET

A GLOBAL STRATEGY TO INTRODUCE
LOW-SULFUR FUELS AND CLEANER DIESEL VEHICLES



**CLIMATE &
CLEAN AIR
COALITION**
TO REDUCE SHORT-LIVED
CLIMATE POLLUTANTS

As prepared by the Heavy Duty Diesel Initiative of the Climate and Clean Air Coalition

August 2016

MEMBERSHIP OF THE HEAVY DUTY DIESEL INITIATIVE

The Government of the United States of America, the Government of Canada, the Government of Switzerland, the United Nations Environment Program, the International Council on Clean Transportation

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PREFACE

Diesel engines power the dominant share of goods movement, construction equipment, and public transport vehicles in the global economy. This strategy presents a roadmap to reduce small particulate and black carbon emissions from the global on-road diesel fleet through the introduction of low-sulfur fuels and cleaner diesel vehicle standards. This can prevent an estimated 500,000 premature deaths per year.

The *Global Strategy to Introduce Low-Sulfur Fuels and Cleaner Diesel Vehicles* has been developed by the five co-leads of the Climate and Clean Air Coalition's (CCAC) Heavy Duty Diesel Initiative (HDDI): the Government of the United States of America, the Government of Canada, the Government of Switzerland, the United Nations Environment Programme (UNEP) and the International Council on Clean Transportation (ICCT).¹ It constitutes a core output of the CCAC HDDI, supported and developed to inform the direction of our work to virtually eliminate fine particle and black carbon emissions from new and existing heavy-duty diesel vehicles and engines through the next decade (and beyond). This document builds the case for a strategic global approach by expanding on a set of preparatory studies, which include a market analysis, a refinery analysis, a health benefits analysis and several case studies to illustrate the benefits, identify opportunities and target countries and regions for action. This strategy is also an invitation to partner with the HDDI and CCAC in this global desulfurization effort and it is our hope that this strategy will guide the work of those institutions, governments and experts also concerned with the climate and clean air benefits from low sulfur fuels coupled with cleaner technology.

This strategy was developed on the basis of an oil and diesel fuel market strategy which analyzed oil and fuel flows in terms of quality and quantity worldwide, and a refinery study which analyzed opportunities for refineries to upgrade to allow for the production of low sulfur diesel fuels. Several case studies were analyzed in different regions and the health benefits of switching to low-sulfur fuels and cleaner diesel vehicles were modeled as part of this strategy. Combined, the markets and refineries studies, with the case studies and the health modeling, form the basis of this strategy.²

This strategy does not consider countries that have already adopted, at a minimum, 50 ppm fuel sulfur standards and associated Euro 4/IV equivalent vehicle emissions standards. These excluded countries include most of the OECD nations as well as China and Russia. While opportunities in these countries are not assessed in this strategy, it is important to note that considerable additional health and climate benefits are available from moving beyond 50 ppm fuels and associated vehicle emissions standards to ultra low-sulfur fuels and associated standards, and that additional benefits may also be delivered through improved measures for compliance and enforcement of adopted standards.

The first section (chapter 1) of the strategy looks at the current situation and state of low-sulfur fuel and vehicle emission standards worldwide, including the barriers and opportunities to introducing low-sulfur fuels. It also identifies the benefits of introducing low-sulfur fuels on a global scale in terms of both health and climate gains.

¹ For more information about the CCAC see: <http://www.ccacoalition.org/>

For more information about the Heavy Duty Diesel initiative of the CCAC see: <http://www.unep.org/ccac/Initiatives/ReducingEmissionsFromHeavyDutyDiesel/tabid/133573/Default.aspx>

For more information about UNEP see: www.unep.org

For more information about the ICCT see: www.icct.org

² Supporting refinery and market studies available from <http://www.ccacoalition.org/en/initiatives/diesel>

The second section (chapter 2) presents a roadmap to move to low-sulfur fuels, identifying the countries that are the highest priorities for action, and presenting a ‘markets approach’ based on the fuel trade relationships between countries and within sub-regions. We define four main categories of action based on whether a country primarily imports fuel, has refining capacity, has yet to match fuel quality with vehicle emission standards or has chosen to prioritize clean fuels in cities. It outlines 36 countries for immediate action based on the opportunities available in each.

EXECUTIVE SUMMARY

According to the World Health Organization (WHO), approximately one in eight global deaths in 2012 were a result of air pollution exposure, making this the world's single largest environmental health risk. The International Agency for Research on Cancer has classified diesel engine exhaust as carcinogenic to humans (Class 1). Nearly half of these early mortalities are associated with outdoor air pollution. Without additional actions, the contribution of outdoor air pollution to early deaths will continue to increase. The main cause is fine particles (PM_{2.5}). Vehicles are significant sources of PM_{2.5} and in many cities the major source. To reduce PM_{2.5} emissions from vehicles there is an **urgent need to introduce low-sulfur fuels** – fuels with no more than 50 parts per million (ppm) sulfur, and ideally ultra low 10 or 15 ppm sulfur. Low-sulfur fuels are also necessary for the **introduction and effective operation of cleaner vehicles and emission control technology. This combination of cleaner fuels and vehicles will have major health benefits and deliver substantial climate benefits through the reduction of short-lived climate pollutants** (i.e. black carbon).

This strategy considers desulfurization of on-road fuels globally. It excludes countries that have already adopted both on-road fuel sulfur standards of 50 ppm or below and vehicle emissions standards of Euro 4/IV equivalent or higher. 85% of road transportation is powered by diesel engines. A global transition to low sulfur on-road diesel and associated vehicle emissions standards by 2030 in the countries considered here would result in about 500,000 avoided deaths per year by 2050. The net present value of the health gains to 2050 is estimated at \$18 trillion. The total costs of desulfurization and emission controls are estimated at around \$1.1 trillion over the same period; therefore, **estimated benefits to 2050 outweigh costs by a factor of around 16.**

Many countries worldwide have already capitalized on these benefits by moving to low and ultra low-sulfur fuels through updated fuel quality standards and/or by upgrading their refineries to produce low-sulfur fuels. However, **more than half of the world's countries are still using high-sulfur fuels.** These are mainly low-and middle-income countries spread across Latin America, the Caribbean, Africa, the Middle East and Asia-Pacific. Global progress on desulfurization has been impressive over the past decade, but it needs to be accelerated and more widespread. Many of the benefits of desulfurization can be delivered with 50 ppm low-sulfur fuels, but the largest health improvements and climate benefits are associated with ultra low-sulfur fuels of 10 or 15 ppm.

This document presents a strategy for how the world can transition to low-sulfur fuels and cleaner diesel vehicles within the next decade. It also outlines why this is imperative for both health and climate goals. Achieving this change will require a focus on countries that are fuel importers, those struggling to secure financing for refinery upgrades, and those that have yet to match already-available low-sulfur fuels with the vehicle emission standards that secure the full air quality and climate benefits of desulfurization. In import-dependent countries, implementing new standards should not take more than two years. For countries with refining capacity additional time between rule promulgation and implementation will be needed but should not take more than five years.

The global fuels market is complex. Some countries are entirely self-sufficient in refinery capacity; in fact, some export considerable quantities of excess fuel. Others complement local fuel production with imports, while many have no refinery capacity at all and are entirely dependent on fuel imports. **This strategy focuses on the local markets in which countries are operating and proposes ways for these countries and markets to move to low-sulfur fuels within a feasible timeframe.**

Import-dependent countries are generally at an advantage in the adoption of low-sulfur fuel standards; low-sulfur fuels are readily available on the global market. Therefore, rapid adoption of low sulfur standards is attainable for these countries. The transition to low-sulfur fuel standards can be more challenging for **refining countries** since considerable investments must be mobilized to increase desulfurization capacity to produce low and-ultra-low sulfur fuels. Partnerships of private, public

and development/donor finance have allowed desulfurization to proceed in many countries and we highlight case studies of where this has happened. By coupling desulfurization to investments in increased refinery capacity investors can improve the financial case for projects by allowing costs to be recouped through increased sales revenue.

Climate and Clean Air Coalition (CCAC) support and engagement should be targeted to countries and markets in which progress will likely lag or stagnate without additional support, where the potential health benefits are greatest and where action may catalyze additional improvements in related markets. While some of the largest refineries and fuel markets offer the largest health benefits from desulfurization and are well-placed to invest in desulfurization within regional and global markets, **a global transition and market for cleaner fuels and vehicles will require support in all developing markets.** The CCAC's engagement can be transformative in setting this transition in motion and partnering with initiatives and institutions beyond the CCAC will only strengthen this global effort and hasten desulfurization by 2030.

This document describes **four strategic categories of regional and national action:** 'importers', 'refiners', 'vehicle standards' and 'cities first'. The division of countries and regions into these categories guides our global approach to desulfurization. Based on the supporting research on markets and refinery operations several countries within each category stand out as key near-term opportunities for action.

We identify 13 countries in the "Importers" category. Because they are dependent on imported fuel, these countries can act relatively quickly to adopt new fuel standards, thereby reducing air pollution nationwide and driving forward regional and global demand for low-sulfur fuels. They make up the largest group of countries and have extensive influence on markets. Low-sulfur fuel could be provided through imports from the international market and the shift in regional demand from high-sulfur fuel to low-sulfur fuel will also spur investment in Refiner (category 2) countries.

The second category, called "Refiners," shortlists 13 countries. These countries have refining capacity that must be upgraded to support low-sulfur fuel standards domestically and regionally. While these countries face challenges in securing financing to upgrade their domestic refineries, they stand to gain from the investment by offering a higher-value fuel product that can be sold to an ever-growing market for low-sulfur fuels, especially when combined with increased capacity. Some refining countries still offer fuel subsidies that may undercut the ability of national and private refineries to recover refinery upgrade investments. This is a barrier that should be addressed through national policy.

The third category "Vehicle Standards" identifies 12 countries that have already achieved low-sulfur fuels but have not yet implemented commensurate cleaner vehicle standards that would maximize health and climate benefits from cleaner fuels and vehicles. These countries can gain from adopting stricter vehicle emission standards that align with the already-available fuel quality for both light- and heavy-duty vehicles; they can also take a leadership role within their regions, sharing their experience with implementing low-sulfur fuel in regional forums.

The first three categories prioritize countries in Africa, Asia, South America, Middle East and Eastern Europe for immediate action.

The fourth "City First" category includes three countries that have introduced more stringent fuel sulfur standards in cities, or in urban areas and along major transit corridors, **and require cleaner fleets to benefit from cleaner fuels available.** This adoption pattern is prevalent in South America, and has also been pursued in China and India. The "city first" model allows for rapid adoption of cleaner fuel and vehicle standards in high-impact urban areas during the period when refineries are transitioning to low-sulfur fuel production but do not have the capacity to meet national demands.

The strategy does pose logistical difficulties and risks of mis-fueling, but these risks can be reduced when accelerated fuel and vehicle standards are paired with a captive fleet with a centralized fueling location, such as a Bus Rapid Transit system. Countries should consider this a transition strategy, and plan a nationwide transition to low-sulfur fuels following urban implementation.

Our analysis identifies 36 countries in four categories for possible immediate action (Table A). Five countries (Nigeria, Pakistan, Malaysia, Indonesia, Tunisia) are identified in two categories, indicating options for multiple approaches. **Implementing the recommendations of this strategy would result in a near-elimination of on-road high-sulfur fuels and pave the way for reductions of 90% or more in small particulate emissions and black carbon of the global on-road vehicle fleet.**

Table A: Priority countries for action, by region and strategic category

REGION	CATEGORY 1: IMPORTERS	CATEGORY 2: REFINERS	CATEGORY 3: VEHICLE STANDARDS	CATEGORY 4: CITY FIRST
Sub-Saharan Africa	Ethiopia	Cote d'Ivoire	East Africa region: Kenya, Uganda, Tanzania, Rwanda and Burundi	
	Mozambique	Ghana		
	Nigeria	Nigeria		
		South Africa		
Asia	Pakistan	Pakistan	Brunei	
	Bangladesh	Indonesia	Indonesia	
		Malaysia	Malaysia	
		India		
Latin America & the Caribbean	Central America region: El Salvador, Guatemala, Nicaragua and Honduras	Venezuela	Panama	Argentina
			Barbados	Brazil
				Peru
East Europe	Georgia	Ukraine		
	Moldova			
Middle East and North Africa	Lebanon	United Arab Emirates	Oman	
	Tunisia	Kuwait	Tunisia	
		Bahrain		

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