# Policy recommendations for emission controls of mobile sources

## I. Control measures for vehicles, machines and vessels

1. In general, engine measures and emission after-treatment technologies are available to bring pollutant emissions from mobile sources down to a very low level. These techniques are usually only introduced if required by EU (international) regulation and, hence, deliberate EU wide political action will be necessary if pollutant emissions are to be further reduced.

2. Often, the implementation of specific emission control measures requires certain infrastructural and technological backup. A characteristic example refers to specific $NO_x$ and PM emission control options that require high quality and low sulfur fuel. This may not been widely available in all regions (e.g. EECCA), thus limiting the range of technologies which can be used. Lifting such limitations may enable wide implementation of efficient emission control options in all regions concerned.

3. The performance and durability of emission control equipment have improved substantially over the years. However, there is a need to bring compliance testing better in line with the actual in-use operating conditions, including extended coverage of power regimes and temperature windows. A revision of certification testing for road vehicles is under way with forthcoming World Harmonized Testing Procedures. Technical developments in the area of Portable Emission Measurement Systems do nowadays allow the measurement of emissions during real-world operation. For non-road machines, locomotives, railcars, and vessels, certification and in-use tests should be further developed to better reflect their diverse and dynamic in-use conditions.

4. The relative contribution of so far unregulated emission sources, such as PM from maritime shipping and aircraft, evaporation emissions from small gasoline engines, but also emissions from small stationary engines which will only be addressed in the future, also increases, as further emission controls are introduced for other vehicle and vessel types. Covering all mobile sources, regardless of size, intended use, and configuration by emission regulations should be reviewed regularly.

5. The contribution of non-exhaust emission sources, primarily PM from component wear and VOC emissions from fuel evaporation may increase in the future, due to increase in activity and because of changes in fuel properties. While fuel evaporation is currently controlled by regulations for most vehicle and engine types (with the exception of small non-road engines), attention should be given to the increasing contribution of non-exhaust PM emissions.

## II. Fuel choices

6. Negligible amounts of ash, including lead, and very low levels of sulfur are necessary for a durable operation of the most advanced emission control equipment. Such fuels need to be reliably supplied to mobile machines so that latest emission control technologies can work adequately. In particular, low sulfur and low ash fuel enables PM and $NO_x$ emission control retrofits, in addition to directly contributing to reduced air toxics emissions. Making high quality fuel available to all regions is therefore of importance.

7. Alternative fuels offered for spark ignition vehicles, such as natural gas, liquefied petroleum gas and bio alcohols, are often promoted as ‘clean’ alternatives to conventional fuels. When compared to gasoline, most alternative fuels offer limited or no net emission improvements. In several cases, alternative fuel use may lead to a reduction of a specific pollutant, but it might also result to an increase of other toxic, but non-regulated, pollutants. In addition, retrofits of existing vehicles to run on alternative fuels entail the risks of increased emission levels due to often limited technical sophistication of the retrofit technology and the lack of efficient mechanisms to verify the quality of the retrofit and the resulting emission level in the real world. Therefore, fuel changes for spark ignition vehicles need to consider changes in the emission profiles of both regulated and non-regulated pollutants as well as possibilities to verify the in-use emission performance of modified vehicles.

8. Alternative fuels for diesel combustion include first generation biofuels, renewable diesel and dimethylether (DME). First generation biodiesel does not lead to substantial changes in air pollutant emissions, at least for the blending ratios it is regulated at. DME and renewable diesel may lead to reductions in both PM and $NO_x$. Their economical production, wide availability, and engine tuning which may be required, in particular with the DME, are issues that need to be resolved before their widespread implementation. However, both options are worth exploring further.

9. Electric propulsion including hydrogen-powered fuel cells, enabling zero tailpipe emissions, may avoid local air pollutant emissions in specific applications. If produced from low-carbon sources, electric propulsion offers a powerful option for reducing greenhouse gases and diversifying the primary energy sources.

## III. Non-technical measures and issues of implementation

10. The implementation and regulatory condition set determine to what extent technical measures can reduce pollutant emissions Economic incentives and disincentives can speed up the uptake of new and the phase-out of old technologies; management of demand and operation can smooth both the operating conditions as well as total pollutant load. Information and monitoring can be considered likewise best practice in the implementation of measures.

11. The contribution of old stock to total pollutant emissions increases as tighter emission limits are introduced for new vehicles and machines. This is particularly pertinent for long-living stock, e.g., locomotives, vessels, certain high-power construction machinery or agricultural tractors. Therefore, measures targeting the phase-out or emission upgrade of old stock can be particularly effective in reducing pollution loads.

12. Provisions for regular screening of emission control equipment could make emission control of the existing stock more effective. Periodical testing procedures should address the complete stock of vehicles and have historically been proven effective. Technical improvements including coverage of more pollutants ($NO_x$, particle number, etc.), increased sensitivity in the measured pollutants, and enhancement of these methods to cover a wider range of vehicle operating conditions however are required so that the inspection continues to be effective in the future.

## IV. Upcoming issues

13. Regulations in place to control $CO_2$ emissions can promote technologies with higher emissions of air pollutants, including those not currently regulated. One example is the increased particle number emissions from gasoline direct injection vehicles. Enhanced measurement and control protocols will have to be developed to avoid unintended consequences.

14. Technologies that are introduced to control regulated pollutants often result in the production of secondary pollutants, as side effects. Examples include certain diesel emission control systems, which can lead to increased emissions of $NH_3$ and $N_2O$. Similar effects may be observed with alternative fuels, in particular those derived from biomass. Examining the impact of technologies on both regulated and non-regulated pollutants and possibly an extension of the measurement protocols for these additional pollutants is required.

15. Several pollutants for which air quality limits exist or which are known to be toxic still remain (largely) uncontrolled. As a result, limited or even no information is available and, consequently, the contribution of road transport to ambient concentrations of these pollutants may be misjudged. Particular examples include oxygenated species, like aldehydes and ketones, which are not part of the hydrocarbons emissions currently regulated, chlorinated species like HCB for which emissions need to be reported but no emission measurements are available, and particular hydrocarbon species like benzene or benzo-a-pyrene for which knowledge on the impact of fuel properties and after-treatment operation is very limited.