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QUANTIFY

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Description of model setup for calculating effects of mitigation options

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Description of model setup for calculating effects of mitigation options

Introduction

The term ‘Mitigation’ is usually referred to as a possible action aimed at reducing the extent of global warming, or more specifically in the context of Quantify, the radiative forcing caused by the transport sector. At the core of most proposals for mitigation is the reduction of greenhouse gas emissions through reducing energy use and switching to cleaner energy sources. According to the description of work activity 3 is to look at different options of mitigation. As mitigation was removed from Activity 1 it was not possible to obtain gridded emission scenarios that are explicitly designed as mitigation scenarios for all the transport sectors. However, efforts have been made to provide one green scenario for the aviation sector, and one hydrogen/biofuel scenario for the road traffic sector.

Implementation

Activity 3 plans to look at the year 2050. A closer time horizon such as 2025 would have produced a less clear signal. Also it seems unrealistic, especially in the aviation sector, that mitigation option such as alternative fuels will be implemented on a large scale within only a little more than 15 years. The year 2100 on the other hand is too far to devise realistic scenarios and would rather serve as sensitivity tests. Also, 2050 seems to be of more imminent relevance for policy at the moment.

Aviation. For the aviation sector it was decided to use the “B1 ACARE” scenario as a mitigation scenario. Quoting Table 1 of deliverable D.1.2.2.2, B1 ACARE is based on the following assumptions (A1 and B1 are shown for comparison):

Scenario	Traffic Demand	Technology description
2050A1(i)	A1 GDP driven	Moderate to good fuel efficiency, moderate NOx improvements
2050B1	B1 GDP driven but intra-regional growth decoupled from GDP	Good fuel efficiency improvement, good NOx improvements
2050B1ACARE	B1 GDP driven but intra-regional growth decoupled from GDP	Excellent fuel efficiency and NOx improvements : ACARE targets achieved in 2020 and continuing improvements beyond 2020

The “B1 ACARE” scenario has the lowest emissions due to the implementation of the ACARE¹ targets for fuel and NOx: this could be described as a mitigation scenario as the fuel efficiency improvements are most likely to be implemented due to concern over climate change. B1 ACARE can thus be seen as a very optimistic but feasible scenario.

Surface traffic. Emissions of short-lived species will be largely eliminated by the year 2050 (Jens Borken, pers. comm.). However, it was decided to look at alternative fuels, with special focus on CO2 reduction options. Ozone precursors will still be looked at, even though their impact might be small even in the marker scenarios.

A sensitivity study for road traffic mitigation has been suggested by Kristin Rypdal (Cicero) and is currently being discussed with Jens Borken (DLR). We assume that hydrogen fuel vehicles are

¹ Advisory Council for Aeronautics Research in Europe has formulated environmental targets for the industry, published in their Strategic Research Agenda (<http://www.acare4europe.org/docs/ASD-exec%20sum-2nd-final-171104-out-asd.pdf>)

introduced more quickly than assumed in the SRES scenarios. The scenario is compiled on top of scenario B1.

Fuel consumption in 2050 (B1) in million tonnes toe (from Borken and Steller)

Gasoline	362
Diesel	1526
Biogasoline	238
Biodiesel	320
Electricplus	101
Gasliq	95
Coalliq	8

In these data 'Electricplus' includes hydrogen among i.a. direct use of electricity for propulsion. In the mitigation dataset we assume that in 2050 half of the conventional gasoline and diesel in the B1 in fact is replaced by hydrogen fuel. Thus the corrected dataset is based on the following:

Fuel consumption in 2050 in million tonnes toe

Gasoline	181
Diesel	763
Hydrogen	472
Biogasoline	238
Biodiesel	320
Electricplus	101
Gasliq	95
Coalliq	8

The replacement of gasoline and diesel with hydrogen fuels implies less emissions tank-to-wheel, but an increase in emissions from hydrogen production and a decrease in emissions from oil and gas production.

Total emissions_mitigation = Direct emissions_mitigation + Indirect emissions_mitigation

Indirect emissions_mitigation = Indirect_hydrogen + Indirect_oil (corr)

We assume that emissions from gasoline and diesel are halved in accordance with the reduction in fuel consumption. We assume that the reduction takes place uniformly across the grid (and not confined to any particular region).

Hydrogen may be produced through different pathways. Van Ruijven et al. (2007) analysed an optimistic H₂ scenario with and without a climate policy. We assume here that a climate policy is in place. They have modeled 4000 GW capacity for hydrogen production in 2050 of which most is produced from natural gas with CCS. We consistently assume here that 60 % is produced from natural gas with CCS, 20 % from coal and the rest from solar thermal (assuming no emissions).

Emission factors are provided in the JRC report on well-to-wheels emissions. These data sets can be constructed as JBS did for the indirect emissions and using the same assumptions about the grid-ding.

Use of hydrogen may also result in enhanced fugitive emissions of hydrogen. Few data are available, but the issue was analyzed by Schultz et al (2003). We assume here a H₂ loss rate of 0.1 % per year.

The indirect emissions from oil production are reduced accordingly (halved). Gridded data are available from RBS (disaggregated datasets for the indirect calculations)

Well-to-tank emissions are included in the non-transport emissions so these need to be corrected accordingly.

Cicero is going to provide gridded emission fields in collaboration with DLR.

Selected models of Activity 3 will do simulations with the B1 ACARE scenario for aviation and the sensitivity experiment for road transport. The background atmospheres will be defined as in the experiments for the SRES marker scenarios, i.e. SRES emissions of ozone precursors and climate gases, and WMO suggestions for chlorine and bromine containing gases. It is assumed that only CTMs with today's climate will do the study.