Greenhouse gas emissions from transport source

PHD Vangelica Jovanovska
Faculty of Biotehnical sciencies - Bitola,
Partizanska bb.
Email: vangelicaj@yahoo.com

Mc.scs Nikola Jovanovski
Tim Jugoelektro Bitola,
Marsal Tito 154/31, E-mail: timjugo@t-home.mk

PHD Toni Paspalovski
ELEM-Skopje, Macedonia
paspalt@yahoo.com

Doc. d-r Zlatko V. Sovreski, PhD.
University Goce Delcev - Stip Macedonia
E-mail: zlatko.sovreski@ugd.edu.mk

Abstract - ***The transport sector is comprised of a diverse set of activities connected by their common purpose: To move people and goods from one place to another. The sector encompasses such varied activities as walking to the corner store to pick up some milk, driving a car to a theatre, and flying fresh mangoes halfway around the world for consumption by residents of northern countries in winter. While all of the sub-sectors within the transport sector share a common purpose, they do not necessarily share greenhouse gas emissions characteristics. Hence, greenhouse gas emissions reduction solutions for different kinds of transport can be quite varied.***

There are five physical elements of the transport sector that can be changed to reduce emissions: Vehicle efficiency, greenhouse gas intensity of the fuel used, level of transport activity, mode of transport chosen, and amount of capacity used.

Key words– Fuel,emission,alternatively fuelled vehicles, transport

I. Introduction

All potential CDM and JI projects with in the transport sector must thus aim to affect at least one of these five elements. The diversity of projects to reduce potential greenhouse gas emissions in the transport sector is immense. Some of these projects fit well into categories that have already been thoroughly explored in previous baseline studies. For example, fuel efficiency and fuel switching projects in transport are only slightly more complicated than similar projects in the electricity sector .Other potential CDM and JI projects in the transport ways. It is important to note that often the same goal can be reached using a variety of different policy and investment actions. Sometimes, one of the possibilities stands out as the least expensive or the most politically feasible within a certain country's particular context.

II. Use

A. Efficiency

Change the fuel efficiency of vehicles without changing the type of fuel that the vehicles use. Although increasing the technical fuel efficiency of a vehicle clearly requires some form of physical alteration of the vehicle, there are a number of potential avenues to arrive at this sector are quite different from anything that has been explored thus far in OECD/IEA baselines work. These include the use of technological advances to improve the efficiency of freight delivery systems3, the forming of a car-sharing organization in a city where car ownership is projected to rise quickly, or economic incentives for individuals and companies to use more efficient transport systems and equipment. Here, the five options to reduce greenhouse gas emissions from transport are identified and examples are given of policies and technologies that would reduce greenhouse gas emissions in each of these outcome. They include direct investment for a physical change in vehicle design to improve fuel efficiency such as fuel injection engines or more aerodynamically shaped vehicles, refurbishment of vehicle fleets, direct economic incentives for fuel efficient vehicles such as feebates5 or scrap page programs, and indirect economic incentives for fuel efficient vehicles such as fuel taxes.

B. Fuel

Change the type of fuel that vehicles use. As in the case of increasing a vehicle's fuel efficiency, there is only one physical way to change the fuel that a vehicle uses, but there are a number of possible policy and investment avenues. Directly investing in the development and marketing of alternatively fuelled vehicles is one avenue. Others include direct and indirect economic incentives for the purchase of these vehicles such as a feebate system, purchase subsidies for alternatively fuelled vehicles, and differing fuel taxes and subsidies for the different transportation fuels.

C. Mode

Mode switching refers to change in the proportion of transport services provided by the different modes (bicycle, car, bus, train, etc. for passenger travel and truck, rail, ship, etc. for freight transport) without changing the technologies and fuels within each mode. Specific investments that would contribute to this type of change include increasing and improving transit service to induce higher ridership and the creation of more intermodal freight transport centers. Policy incentives for people to switch to lower greenhouse gas emitting modes include transit subsidies, raising parking

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D. Activity

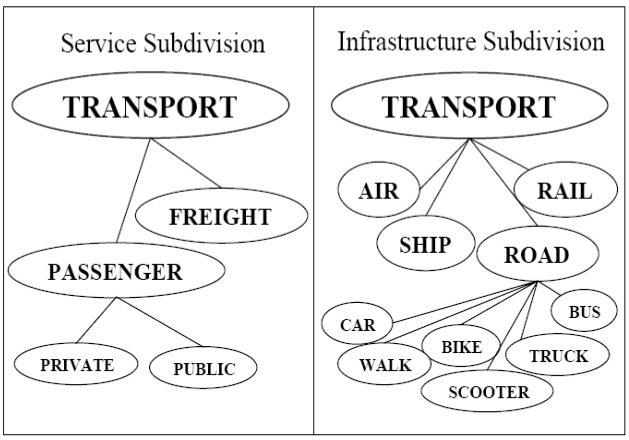
Change in the absolute distances that people and freight travel. While this is conceptually the most straightforward of the ways to affect greenhouse gas emissions from transport, it is often the most difficult to put into practice. This is because reducing transport *activity* requires individuals to change their behavior. Some examples of technologies and policies that could produce activity reductions are optimizing logistics for goods delivery, telecommuting, and designing compact towns and cities with mixed-use zoning.

E. Load

Change in the occupancy, or *load factor* of vehicles. Incentives for carpooling such as priority parking and use of less crowded lanes on roadways, optimizing logistics for goods delivery, and making public transit vehicles more comfortable so that higher occupancies can be reached are all examples of initiatives that reduce greenhouse gas emissions by optimizing vehicle load factors. Projects that utilize these five physical ways to affect greenhouse gas emissions from the transport sector can be implemented in different subsectors within transport. In order to clearly see where projects are possible, it is useful to subdivide the overall transport sector into smaller pieces. Analysts and governments traditionally subdivide transport in one of two basic ways (*Figure 1*). These subdivisions are not necessarily related to the potential for projects. However, thinking about transport in each of these ways in addition to as a whole is useful for envisioning the large range of potential greenhouse gas reducing projects that are possible.

The first way to subdivide the transport sector is by the infrastructure that is needed. Dividing the transport sector in this way, the obvious sub-sectors are road, rail, ship, and air.6 The benefit for greenhouse gas emissions analysis of subdividing the transport sector in this way is that greenhouse gas emissions characteristics of transport technologies are similar within each of the four sub-sectors. The second possibility for the division of the transport sector into sub-sectors is to organize the various modes of transport by the service they provide. Using this rule, the sub-sectors are passenger transport, divided into private and public, and freight transport. There are two advantages of subdividing the transport sector in this way. First, this division is the way transport demand is generated and therefore it is convenient for

Figure 1: **Two ways that the transport sector is traditionally subdivided**



economic analysis. For instance, if there were a price change for freight transport by rail, this way of thinking about the transport sector allows the analyst to explore the effect that this would have on other freight transport modes. The second advantage is that each of these sub-sectors is often overseen by a single company or governing body. For certain potential CDM or JI projects in the transport sector, this existing centralization of decision making for subsectors within transport may be very useful for data gathering and/or project implementation.

While using this framework and thinking of transport as a number of smaller sectors helps to clearly see the project options, these subsectors interact in complex ways. This interaction often necessitates the consideration of more than one subsector of transport in both baseline generation and project emission measurement. This is because the transport system is like a web – each part is connected to every other part in some way. When an action is taken in one part of the transport system, it often affects greenhouse gas emissions in other transport subsectors.

There are two ways in which a project can affect emissions outside its direct target – through spillover effects and through interaction effects. These effects occur after the project is implemented, and are therefore much more important for post-project emissions measurement than for baseline development and estimation. However, as will become clear, in order to be able to compare the post-project emissions measurements directly with the baseline to determine the CERs or ERUs earned, it is necessary to keep these effects in mind when developing baselines. Also, since these effects will impact the number of credits earned by a project, having a good estimate of the emission implications of spillover and interaction effects will help project evaluation.

III. SPILLOVER EFFECTS

Many potential CDM and JI projects in the transport sector are likely to cause significant "spillover" effects. This means that an implemented project will not only reduce emissions directly, but it may have other effects on net greenhouse gas emissions that are not so obvious at first glance – positive OR negative. These effects can be either outside the "box" that the original project was planned to affect or they can be secondary effects that are inside the "box".

In this report, all of these effects are divided into two types:

- Technical effects and economic effects. Both kinds are extremely challenging to measure. An economic spillover effect occurs when a project causes a price change that affects demand for a good that significantly changes greenhouse gas emissions, but the price change was not the main objective of the project. A technical spillover effect occurs when a project causes an upstream or a downstream physical change that is not the main objective of the project, but that alters greenhouse gas emissions in the system. For example, a fuel switching project that converted buses from diesel to compressed natural gas (CNG) fuel could lead to the technical spillover effect of additional methane leakage from natural gas pipelines that accompanies increased use of natural gas. The increased use of natural gas may reduce greenhouse gas emissions when it replaces gasoline or diesel fuel, but the spillover effect of the methane leakage increases greenhouse gas emissions. A positive technical spillover effect would occur in a fuel switching project where not only were the tailpipe emissions of the alternative fuel lower than those from the conventional fuel, but the upstream processing emissions for the alternative fuel were also lower. A number of life cycle models have been created to model these types of technical spillover effects in the transport sector, but they are calibrated with detailed data from developed countries. These models could be used to gain an understanding of what types of technical spillover effects tend to be large in the transport sector. However, to use them to actually estimate the size of any particular effect in a developing country, local data would need to be collected.

An economic spillover effect might occur if private vehicle fuel economy were increased. This fuel economy improvement would cause the per-kilometer price of private transport to drop, leading to an increase in kilometers travelled in private vehicles. While the improved fuel economy reduces greenhouse gas emissions, this "rebound" effect of more private transport drives them back upward. A positive spillover effect in an economic sense would occur if a project raised the cost of passenger or freight transport per person- or ton-kilometer travelled while simultaneously reducing the greenhouse gas emissions per unit. A specific example would be a fuel-switching project in which the alternative fuel emitted fewer greenhouse gases per person-or ton-kilometer travelled, but cost enough so that the price of travelling rose. Not only would there be fewer greenhouse gases emitted per kilometer, but there would also be fewer kilometers travelled in response to the price change.

IV. INTERASTION EFECTS

Interaction effects occur when the greenhouse gas emission reduction impact makes the investment, the resulting mode shift is likely to be relatively small. However, if the region is able to co-ordinate the two strategies to generate a positive interaction effect, the resulting behavior change may be substantial.

One would expect a negative interaction effect when a project to improve private vehicle fuel efficiency is coupled with a project that attempts to induce travelers to switch from private to public transport. The first project reduces per vehicle emissions, but also reduces the per-kilometer cost of fuel for private vehicle owners, making their private vehicles even more attractive to use. The second project of a project is affected by other, simultaneously implemented projects. Referring back to the five ways that greenhouse gas emissions from the transport sector can be affected, it is interesting to note that there are often a number of ways to reach the same goal. In different countries with differing economies and political systems, different paths to the goal of greenhouse gas emissions reduction from transport may be suitable. However in each country, one or two of them may stand out as the most, economically or politically feasible path.

Sometimes, it is easy to see that if more than one strategy were implemented, the resulting emission reduction might be greater than the sum of the reductions due to the separate actions. Other times, two or more actions might overlap and therefore lead to a smaller overall reduction when implemented together than the sum of the two actions would lead to separately.

Conclusions

To illustrate this point with an example that demonstrates positive interactions between a policy and an investment, imagine a region that aims to reduce greenhouse gas emissions by taking actions that will lead to a mode shift from cars to public transit. The region considers the policy of raising the cost of driving via increasing tolls on common routes and the investment of improving public transit service. If the region implements only the policy or just makes public transport more attractive in some way. It is easy to see that, absent the improvement in private vehicle fuel efficiency, the second project would reduce emissions more than in the situation where both projects are implemented simultaneously. The converse is also true. The situation that necessitates consideration of interaction effects in post-project emission estimation is when two separate investors fund projects that interact with each other. In this case, it becomes necessary to divide the credits between the two investors in a fair way without double counting of emissions reductions. One possibility is to base the total emissions reduced on the amount of money invested that led to the emission reduction. Another is to allocate the total reduction according to some engineering estimate of the per cent contribution of each project to the total number of CERs or ERUs generated. While this would provide clearer encouragement for investors to find the cheapest emission reduction opportunities, it might also increase the cost of implementing the projects due to the likelihood of the need to collect further data.

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