CALAC Evaluation Report

Report realized on behalf of SDC

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Contents

Abbreviations

BC	Black Carbon
BDPF	Bogota Diesel Particulate Filter
CA	City Alliance
CALAC	Climate and Clean Air in Latin America's Cities
CARB	California Air Resource Board
CCAC	Climate and Clean Air Coalition
DPF	Diesel Particle Filter
FOEN	Federal Office for the Environment
GHG	Greenhouse Gas
GWP	Global Warming Potential
MMA	Ministry of Environment, Chile
MMT	Ministry of Transport, Chile
NAMA	Nationally Appropriate Mitigation Action
PM	Particle Matter
SDA	Environmental Secretariat of Bogota
SDC	Swiss Development Cooperation
SFU	Santiago Follow-Up
SITP	Integrated Public Transport System Bogota
SloCaT	Partnership on Low Carbon Sustainable Transport
STT	Transport Secretariat of Bogota
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization
WTT	Well-to-Tank

Summary

Objective

1. The project has as core objective to reduce ultrafine particles and mitigate climate change by applying diesel particle filters (DPFs) in urban public transport buses.

Relevance

2. The strategic intervention level of focusing on Black Carbon (BC) from diesel engines is in accordance with national and international policies and strategies. The project focuses thereby on DPFs for urban public transport buses. This focus can be made – however other options to reduce BC within the context of sustainable and low carbon transport can be, depending on the context, more effective, more cost-efficient and more sustainable. The focus on DPFs, especially if including retrofit of buses, should therefore be justified better prior commencement of activities.

3. The project activities and outputs are overall consistent with outcomes in the case of Bogota and Santiago. In the case of the City Alliance activities lack a coherent design and focus on establishing a new website or communication platform which most probably will not lead to the desired outcome.

4. Output indicators are in general appropriate – the project lacks however some obvious outcome indicators e.g. in the case of Santiago actual enforcement and maintenance improvement levels due to project actions. Also actual project impacts (GHG, PM) could be better quantified and monetized.

Impact

5. The project has a positive impact on improving the know-how of involved stakeholders on DPF. This was achieved basically through technical assistance from experts and field visits. The project has no impact on clean air and climate change policies beyond DPF.

6. The beneficiary population is potentially[1] the population of Santiago and Bogota summing 14 million people. Outside these 2 cities the project has no measurable or relevant impact.

7. The particle matter (PM) impact of the project is potentially around 24t PM reduced per annum for 5 years in Bogota which corresponds to 15% of public transport emissions of the city or < 1% of total PM emissions of the city. In the case of Santiago the estimated potential reduction is 2 tons per annum of avoided PM.

8. The GHG impact of the project is for Bogota per annum around 3,000 tCO_{2e} avoided with a GWP100 and around 30,000 tCO_{2e} using a GWP20 again for a period of 5 years. Depending on the scenario chosen the GHG impact could be negative. In any case it can be stated that the project has a limited short-term impact on GHG emissions. As comparison the current hybrid fleet of TransMilenio has based on a GWP100 a 5x higher impact on GHG reduction than the entire DPF program.

[1] The term „potential“ is used as no actual implementation has occurred.

Effectiveness

9. The SFU component has to the moment partially realized outputs and is expected to achieve all outcomes within the next 6-12 months. Documentary reports e.g. concerning DPF policies and Euro VI should however include not only Swiss experience, be more in-depth and be more comprehensive to serve as background documents for replication in other countries.

10. The BDPF component has achieved the outcome of having a regulation in place for BDPF retrofit. However the pilot test phase has not achieved its objectives with only 2 buses using successfully DPFs. The test has not clarified if DPFs are actually technically and financially feasible for the bus composition, altitude and traffic conditions of Bogota. The regulation has legal, technical and conceptual shortcomings and its implementation is questioned. The focus should be more on retrofitting buses with a long remaining life-span (>8 years) and new units and not on buses which will be replaced potentially in less than 2 years. Basically the project effectiveness was hampered due to poor conceptual design, lack of stakeholder inclusion and lack of financial structuring.

11. The CA component to the moment has been largely interchange between Santiago and Bogota which in fact is already a component of the SFU and BDPF. Beyond a visit of the Mexican delegation no activities have been performed. The outreach strategy lacks clarity, consistency and design and is based on an inward-looking property website and platform with limited impact and no sustainability.

Efficiency

12. The project efficiency in terms of resource usage cannot be judged due to multiple on-going activities and de-phased implementation.

13. The project is around 6-12 months behind schedule due to external (counterpart) and internal (planning deficiencies, CA component conceptual) reasons.

14. The cost-benefit of the BDPF for retrofitted buses is probably positive with a societal benefit of between 1 and 7 MUSD cumulative over the entire lifespan of the project including the social benefits of PM and GHG reduction. However results are critical to average values. The project can have a negative benefit-cost ratio based on the safety margin of emission reduction and monetary valuation estimates. This means that it cannot be ensured with a conventional statistical reliability level that the project is positive from the cost-benefit point of view i.e. the project approach is not robust. Benefits are always higher than costs if new buses or such with a remaining life-span of minimum 8 years are fitted with DPFs.

15. Other measures identified such as new technology buses have a better cost-benefit relation for reducing PM and BC. Also various other measures might be more beneficial in financial terms.

16. The project lacks clarity in cost-benefit calculation thus resulting in questionable strategic choices of retrofitting elderly buses instead of focusing on new units. Additionally the lack of financial structuring and identification of available financial mechanisms leads to adding considerable costs to a public transport system already under significant financial strain.

Sustainability

17. Once implemented the project sustainability for Chile and Bogota are in principle given as the local capacities to manage the project are available. The CA component is currently non sustainable.

Recommendations

18. Recommendations focus on extending and expanding the phase I until end 2016 and exiting the project thereafter. Adding on other components of sustainable transport to a DPF centred project would damage focus, would be non-coherent to the overall project design and requires a clear conceptual approach, the appropriate know-how and sufficient time.

19. For the SFU component it is recommended to finish the phase I activities and to include technical assistance for DPFs with off-road machinery.

20. For the BDPF project is recommended to realize a layout of the current status and re-focus activities on such with a significant impact and a high benefit-cost ratio i.e. new buses plus retrofit of Euro IV and V units. The probability of the current regulation being actually implemented is considered as low. The moment is however good to use the regulation as a negotiation instrument to achieve implementation of DPFs in units with minimum 5 and better at least 8 years of remaining life-span plus on new units i.e. go beyond current Euro V requirements.

21. For the CA component the recommendation is to design an outreach strategy based on existing platforms and communication channels and upgrade these with high quality contents, e-learning tools and inter-active chat instruments. The CA component could thus be a content and instrument provider and not a platform itself and use, strengthen and empower existing platforms and channels.

1. Introduction

October 2013 Swiss Development Cooperation (SDC) started together with local partners Phase I of the project Climate and Clean Air in Latin America's Cities (CALAC). After 1.5 years of implementation the external evaluation intends to create a better understanding of the projects relevance, impact, effectiveness, efficiency, and sustainability. In addition, the evaluation shall come up with some ideas/recommendations towards the design of the next phase of the project for 2015-2017.

The evaluation methodology is based on a documentary review and discussions with stakeholders. The documentary review includes project documents as well as relevant literature (see Annex 2). The list of discussions maintained with stakeholders is included in Annex 3. For discussions a trip to Colombia and Chile was made July 13-18, whilst various meetings were also realized in Switzerland.

The following report is fully the responsibility of the external reviewer.

The report is structured around the major evaluation criteria. After a short project summary the following chapters include an assessment of the projects relevance, impact, effectiveness, efficiency, and sustainability. The last chapter includes conclusions and recommendations. Recommendations on future activities are outlined in a separate report.

2. Project Summary

Action for reducing air pollution can have a direct impact in the short-term on the agents of climate change. The project has a combined strategy of tackling greenhouse gas emissions (GHG) while at the same time reducing pollution and therefore improving local air quality with an intended positive impact on health, water and human food security.

The project has as core objective to foster the effective and speedy reduction of air pollutants harmful to human health and mitigate climate change by applying diesel particle filters (DPFs) in urban public transport buses.

It has three components whose objectives are:

- Reduction of soot and ultrafine particles in the integrated public transport system of Santiago (*Transantiago*);
- Reduction of soot and ultrafine particles in the integrated public transport system of Bogota (*TransMilenio*);
- Formation of a City Alliance to encourage rapid action to mitigate climate change and air pollution.

Main partners involved are the Chilean Development Agency, the Ministry of Environment (MMA), the Ministry of Transport (MMT) and Transantiago in Chile and the Environmental Secretariat of Bogota (SDA), the National University of Colombia and TransMilenio in Colombia.

The initiative shall also contribute to the objectives of the Climate and Clean Air Coalition (CCAC), an international platform of over 100 country and non-state partners created to reduce short-lived climate pollutants. Chile, Colombia and Switzerland are, amongst others, coalition members.

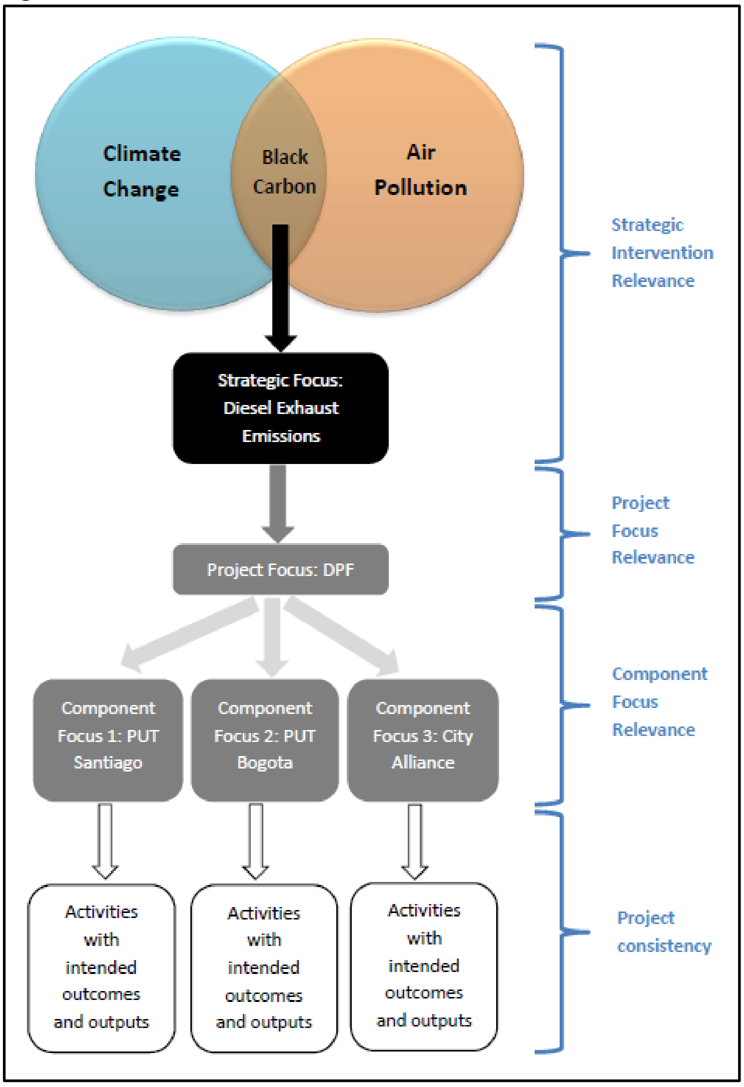
3. Project Relevance

3.1. Introduction

Following aspects of relevance are discussed:

- Consistency of intervention level objectives with the project rationale (strategic orientation) and global priorities including the strategic focus on diesel exhaust emissions;
- Relevance of the strategic project focus on DPFs;
- Relevance of the components objectives including consistency of the objectives with the beneficiaries' requirements and country needs;
- Consistency and relevance of the logical framework (objectives, outcomes, outputs and activities) per component.

Figure 1: Relevance Levels



3.2. Strategic Intervention Relevance

The project rationale is based on the problem that air pollution is a major issue in Latin American cities causing significant social, environmental and economic costs whilst at the same time climate change is a global topic. Diesel exhaust emissions have been identified as a major cause of air pollution problems. Air quality, especially particle matter (PM), and climate change are prominent on the multilateral agenda. The intervention strategy is to combine these two elements through reducing diesel exhaust ultrafine particles and black carbon (BC) thereby reducing short-lived climate pollutants whilst improving air quality. This is commensurate with a strategy also followed by the CCAC formed by the United Nations Environment Programme (UNEP)[2].

Assessment

The project rationale of air pollution problems and climate change continues. Also the strategy to combine the two elements and to focus on diesel exhaust emissions (in Europe, the US and Latin America the largest source of BC[3]) was and remains being valid as expressed e.g. in the CCAC which has an initiative of "Reducing Black Carbon Emissions from Heavy Duty Diesel Vehicles and Engines[4]. BC is a significant driver of climate change, especially in the short-term, and PM is a major air pollution problem. Diesel exhaust emissions are thereby a major factor of BC emissions.

3.3. Project Focus Relevance

The project focuses on DPFs. The overall goal states "The programme's overall objective is to effectively and rapidly foster the reduction of harmful air pollutants to protect human health and mitigate climate change through the application of DPFs"[5].

Assessment

The implementation of DPF implies that measures need to be taken to ensure the appropriate diesel fuel quality as well as maintenance standards. Therefore DPFs requires other measures to be taken.

The focus on DPF can be for retrofit of existing vehicles as well as for original equipment for new vehicles. Only Euro VI or the comparable US standard require the usage of DPFs, therefore the focus of DPFs also has an influence on the emission standards of the respective country.

The project concentrates on a specific technological fix with a clear focus on ultrafine particulates. The impact on climate change is limited (see for a further discussion chapter 6). The concentration on DPFs as the sole project solution seems to be based primarily on historical reasons (the previous DPF program supported by SDC in Chile) and not on an assessment of available options. Under a target of improving air pollution whilst reducing GHG emissions multiple solutions are feasible including e.g.:

- Fostering of sustainable transport strategies which **avoid** traffic e.g. through Transit Oriented Development under implementation for example in Colombia under a NAMA (Nationally Appropriate Mitigation Action) with significant national and international support[6]. Other options include 0-emission zones, pricing instruments etc.
- Fostering of sustainable transport measures which **shift** transit from high to less polluting modes including public transport as well as Non-Motorized Transit.

[2] See Loan Application Nr. 7F-01079.04, strategic orientation
[3] see T.C. Bond et.al., 2013, p. 5385
[4] http://www.unep.org/ccac/Initiatives/ReducingEmissionsFromHeavyDutyDiesel/tabid/133573/Default.aspx
[5] See Loan Application Nr. 7F-01079.04, strategic orientation
[6] AFD and the NAMA Facility Fund

- Introduction of low-polluting vehicle technologies as well as **efficiency** improvements in the operation of vehicles. This includes measures on the fuel as well as the vehicle side such as electric, hybrid or gaseous powered vehicles. For existing vehicle fleets measures such as EcoDrive, low-rolling resistance tires or low viscosity oils all have an impact on fuel consumption and thereby GHG and local pollutant emissions.

The measures listed above can be categorized within the framework of Avoid-Shift-Improve with DPFs being within the category of "improve". Important is the fact that all of these measures are being implemented on a massive scale in various cities worldwide including cities in Colombia. The focus on a technological fix solution like DPFs without prior assessment of relative comparative benefits and costs seems questionable at least for any future phase or project due to:

- Strategies which avoid or shift traffic have significant social, environmental and economic benefits which go beyond air pollution and climate change including improved city liveability, reduced accident rates, reduced space requirements for traffic, reduced congestion etc.
- Most alternative strategies have direct economic benefits next to direct costs e.g. hybrids and electric vehicles result in lower operational costs, efficient tires reduce fuel costs etc. DPFs on the other hand have direct costs (filters, maintenance and additional fuel) but no financial direct benefits[7]. This is relevant for financial strategies and public transport costing as latter depends on direct costing techniques and not on indirect benefits.
- The relative performance level of different options based on a cost-benefit analysis including social costing has not been assessed by the project. Whilst DPFs might have a positive cost-benefit relation this is not a sufficient condition to claim that it is the best solution as other measures might have better cost-benefit relations or other measures might have financial structuring options not available to DPFs e.g. vehicle manufacturers offer electric or hybrid buses with a leasing system including payment of batteries per km and the manufacturer is responsible for replacement, tear & wear and maintenance i.e. performance based contracts are offered for some technical solutions not available to DPFs[8].
- With any technological solutions, especially retrofit, the consequences of financial structuring and implementation need to be taken into account. Increasing contract and life-span for retrofitted buses has the consequence of retarding the introduction of new technologies which might be more beneficial for the climate or reduce more pollution. Burdening additional costs on operators or on the public transport system can lead to financial sustainability problems of involved institutions and/or to price hikes in public transport with the consequential negative effect on trip demand and mode shift[9].

DPFs are potentially a lock-in in a conventional fossil fuel diesel technology. Whilst the merits of DPFs are acknowledged, the fixation on a technological solution is questioned within the width of available options which have a more comprehensive and massive impact on air pollution and climate change. A strategy focusing on DPFs can be complementary to a sustainable mobility strategy – however it is important to take into account the absorption capacity of a transport system to introduce at the same time multiple changes. Therefore priorities need to be set and the potential trade-off between fostering DPFs and pursuing other elements of sustainable mobility should be considered.

[7] Indirect benefits on health or environment are not disputed; the argument here is on direct cost/benefits.
[8] Operators of TransMilenio have e.g. opted for such contracts when acquiring hybrid buses from Volvo.
[9] The price elasticity of public transport demand can be relatively high, especially in poorer countries.

3.4. Component Focus Relevance

The Santiago DPF Follow-Up Project (SFU) focuses on the DPF maintenance practices in urban buses and the further development of DPF policy (specifically off-road). The Bogota project (BDPF) focuses on application of DPF in the integrated public urban transport system. The city alliance component (CA) aims to introduce DPFs and foster alliances between cities.

Assessment

All project components are logically consistent with the focus established at project level on DPFs. An additional focus is laid on public urban transport buses for DPFs plus policy advice in Chile for further DPF application. The reason for this focus on public urban transport buses e.g. instead of focusing on trucks is probably due to historic reasons (the Chilean DPF project), a simple approach due to city control over public transport, less actors and due to partners request. It is not based on an assessment of the relative magnitude of BC within different vehicle categories.

The SFU was designed as a follow-up program and is based on a specific request of the Chilean Environmental Agency. As such the project is consistent with the beneficiaries' requirements and country needs. With the overall successful implementation of the DPF program in buses of Santiago the focus of MMA has shifted towards off-road machinery. Latter is deemed to be a major source of particle matter in Santiago and interest of the authorities exists to extend the approach to mobile machinery. The component design is in line with the air quality improvement strategy of the city.

The BDPF is also based on a local request and on local activities realized previously in this area. Bogota in its ten-year plan to reduce air pollution identified particle matter (PM) pollution as a severe problem and includes as one of various specific measures the introduction of DPFs in the integrated public transport system of Bogota (SITP)[10]. The Resolution 1304 of 2012 asked for DPFs for Euro II and Euro III SITP buses with installations to be realized in the first semester 2013, without however being implemented. The Resolution 00123 of 2014 is more specific concerning DPFs and their installation and requires for their installation starting 2015. The project was and continues to be therefore in accordance with air quality policies pursued in Bogota.

The CA component is basically a strategic outreach instrument. The term "city alliance" seems to be a bit stretched considering the fact that basically a South-South cooperation between Bogota and Santiago plus the facilitation with a Swiss city is envisaged. This shall then be spread out to other cities. The liaison with the CCAC shall also be strengthened without being central. As mentioned this is an outreach strategy to disseminate in a sustainable manner results of DPFs. Numerous city alliances in the environmental area and especially within the climate change field already exist including C40 and CCAC, with Bogota and Santiago being member of both. The necessity of creating an additional body and its benefits as well as outreach alternatives are not discussed in the project documents. Whilst information and experience exchange is important many means, forms and methods exist to manage latter. The creation of new information platforms needs a sound justification and an appropriate strategy to be sustainable, successful and to fulfil its goal. The CA component is not considered to fulfil the requirement of relevance: it can neither show a demand[11]

[10] see AMB, Plan Decenal de Descontaminacion del Aire para Bogota 2010-2020, measure 5b p. 18
[11] Demand implies a willingness to contribute in terms of financial and other resources.

of cities for such an instrument nor is the instrument itself a logical and undisputed consequence of the assumed deficit in information and know-how exchange.

3.5. Project Design and Consistency

Project design relevance and consistency refers here to consistency of overall objective with outcomes (specific objectives or goals) and latter with outputs and activities. It also refers to the appropriateness of the chosen indicators. The consistency of the project with the cities policies was discussed in the former section. The question raised in this section is if outcomes are consistent with and sufficient to attain the intended objective and if outputs and activities are consistent with and sufficient to achieve the outcomes. Tables 1 to 3 in Annex 1 summarize objectives, outcomes and outputs per component as per project documents[12].

Assessment SFU

The SFU objective is the result of two main critical points of the running DPF program being measurement and enforcement. The objective is to reduce the higher than expected DPF failure rates. The component objective focuses on these problem areas which are covered in a consistent and sufficient manner by the outcomes 2 (improvement of enforcement) and 3 (improvement of maintenance). The outputs and activities for an improved enforcement are considered to be consistent and sufficient. The outputs and activities for improved maintenance are considered to be sufficient but not optimal. The focus is on technical maintenance practices and Swiss experience with maintenance. While technical aspects are relevant the main barrier perceived to improved maintenance is **not** lack of know-how on maintenance itself but lack of managerial will to invest additional resources on maintenance (the current practice is perceived to be cost-effective) and lack of organizational know-how for maintenance of large-scale bus fleets under strict operational procedures and directives of a 3rd Party (Transsantiago or TransMilenio). Swiss bus fleets are all small and have no know-how in this respect. The focus on technical aspects and on Swiss experience will probably not result in a significant change of maintenance practice. More relevant would be to engage best-of the class peers of large scale BRT operators in Latin America and provide for South-South know-how transfer.

The component objective also includes the further development of DPF policy which is basically covered in a consistent manner through outcomes 1 (know-how improvement; this is in fact not an objective per se but an instrument to design state-of-the art policies) and 4 (future DPF policy). Outputs and activities of these 2 outcomes are considered as consistent and sufficient.

The outcome 5 (dissemination) is not inconsistent with the objective but was not identified as a problem of the current DPF program i.e. it is not considered a necessary outcome to achieve the objective. The sole output or activity of the outcome is a DPF conference including also Latin American cities. This activity might rather be considered an element of the CA component at least if the target is Latin American cities. Whilst conferences can be a dissemination tool it is questioned if this is today still the most appropriate and cost-effective approach for dissemination and outreach.

The chosen indicators are appropriate for all outputs. No indicators have been identified at the outcome level however which is considered as a deficiency as the project monitoring is geared

[12] slightly shortened for improved readability

entirely on number of reports, compilation of documents and visits. The monitoring scheme should also give some feedback on the efficacy and impact of measures taken. It is recommendable therefore to also include outcome indicators. For outcome 2 (Santiago's DPF enforcement scheme is improved) and outcome 3 (Santiago's DPF maintenance practices are improved) the indicator could be "% of buses with non-compliant DPF" complemented with "efficiency level of DPF monitored"[13]. Output 2.2. indicates the baseline or starting point and a 2nd, shorter measurement campaign could be realized at the end of the project to monitor performance improvement. Such measurements should anyway be performed on a regular base by the implementing agency to monitor their efficacy of operations. The same could be done for outcome 3 with a comparable indicator and procedure.

Assessment BDPF

The outcomes are consistent and sufficient with the component objective and include pilot testing, regulation design, implementation incl. enforcement and dissemination. They take into consideration the problems of enforcement and maintenance identified in the first stage of the Chilean project. Outputs and activities within each outcome are also considered to be consistent and sufficient. Concerning activities related to maintenance see comments on SFU component.

The chosen indicators are appropriate for all outputs. Some outcomes could easily have a direct indicator e.g. outcome 2 (local approval scheme for DPF) could have as indicator "legally approved local DPF scheme".

Assessment CA

The outcomes focus on a dissemination strategy based on interchange of experiences through participation at events in Santiago, Bogota and Switzerland, the establishment of a city alliance and of an Internet platform. The exploration of interests seems a bit queer as this in fact would be a pre-condition for realizing this component. As presented the component seems to be supply or consultant driven.

Basically the component wants to ensure that, under the pre-condition of existence of interest, cities can replicate in a cost-effective manner DPF projects and that cities can learn from experiences. It is questioned if the outcomes and activities are sufficient and relevant for this objective. Outcomes as formulated are basically activities and not intended effects e.g. a dissemination platform or a city alliance is an instrument and therefore classically an output and not the intended effect. Independent of this apparent confusion the usefulness and the relevance of establishing a platform as well as a city alliance is questioned (see for a further discussion of this aspect also the chapter on effectiveness). Alliances and websites exist by the thousands with many being useless. The component lacks as outcome a clear analysis of needs and demands of involved cities, and an assessment of existing and available communication networks and experience interchange channels as used by Latin American city officials. It also lacks the aspect of financial sustainability. The component jumps on certain activities (website, city alliance) without showing why these are necessary, relevant or sufficient to achieve the objective.

[13] The 2 indicators are required to determine the improvement level due to better enforcement and maintenance as improvement levels are the product of reduced failure rate and the performance level of DPFs which fail the test (the DPF could be working at any level between 0% and the pass-level)

The chosen indicators within the CA scheme of the project are appropriate for all outputs.

4. Project Impact

4.1. Introduction

Impacts are long-term effects produced intentionally or not by the program. This section will therefore look at the direct impact of the project on the stakeholders in terms of developed capacities and the impact of the project on policies and on the other hand the impact on the beneficiaries in terms of reduced air pollution and climate change.

4.2. Impact on Stakeholders

In both countries capacities and know-how on DPFs already existed, but has been further enhanced by project activities shown by:

- In the case of Bogota the know-how of various involved stakeholders on the importance of ultra-fine particles, qualitative differences between different particles filters, importance of improved bus maintenance and of a staged process has improved. A core information component was also that Euro IV and V buses do not resolve the particle problem of diesel engines. Capacity enhancement has been made primarily through meetings with Swiss experts and field trips to Chile and Switzerland.
- In the case of Santiago capacity on monitoring methods has been enhanced. Also the usage of DPF on mobile machinery has been highlighted sparking interest to extend the project to this sub-sector. The major factor for increasing the capacity primarily of MMA were the involved Swiss experts.

Capacity enhancement focused on DPF i.e. the capacity of the stakeholders in activities to address climate change and air pollution has increased in this specific instrument to address the problem, not however in other instruments or approaches. This is not surprising due to the (intended) project focus and also the assistance sought by the stakeholders specifically on this topic.

Climate change and air pollution continue to be or have even increased in importance on the political agenda of both involved cities. However this is not due to the project as latter focused largely on technical matters related to DPF including improving regulations in this area. The project is clearly well positioned within the political priorities of both cities but has had no significant influence or relevance in climate change and air quality aspects outside the realm of DPFs. This fact is clear e.g. in the case of Colombia where the project had no interactions with the Ministry of Environment and its climate change division or with the Ministry of Transport and its division on sustainable transport both of which are core actors of gearing Colombia towards low carbon, sustainable transport.

One of the capacity building instruments in the case of Bogota was also the promotion of a cost-effectiveness tool and the promotion of the WHO model for determination of health benefits. The cost-benefit tool was applied to Bogota for determination of the regulation but has not been further used. The WHO model has not yet been used by the project. The usefulness of the cost-effectiveness model is questioned by the evaluator due to its complexity and lack of transparency in the determination of core parameters such as investment and maintenance cost. Additional fuel costs, one of the main costs of the measure, are also not included in the model. Technically it is also questionable to discount costs but not benefits. Depending on values set for parameters resultants will vary widely. For such a tool to be useful it should:

- Focus on core elements and equations and strip the tool of non-essentials which reduce readability and result in a complexity level making the model of limited use;
- Include in a transparent manner all costs including a discussion on values used and the certainty range of values;
- Include the GHG and PM2.5 impact in emission and monetary terms;
- Allow for simple sensitivity analysis of core parameters.

Overall the project has had a positive impact on capacity enhancement in DPF for urban buses. This is the case especially for Bogota. This capacity has basically been enhanced due to the recognized Swiss experts and the field visits to Switzerland and Chile. The project had no impact beyond DPF on the broader discussion of climate change and air pollution in urban areas.

4.3. Impact on Beneficiaries

As of July 2015 the project had no impact yet on air pollution, climate change and therefore also no beneficiaries. This is due to the fact that no concrete project implementations which affect the air quality or climate change have been realized due to the project as of this date[14]. This is mainly due to time delays.

Until end of this phase the project will have as beneficiaries potentially the entire population of Bogota and Santiago as the whole population is affected by air quality improvements. This includes a population of around 14 million people[15]. The project claims as beneficiaries also the populations of Sao Paulo, Lima and Buenos Aires totalling 49 million persons. However no concrete activities have been undertaken. Whilst a first contact and site visit of Mexican officials in Chile (July 2015) has been realized the level of impact based on project influenced activities is considered as very marginal. Also the impact of the up to now non-existent dissemination platform is considered to be extremely indirect and based primarily on wishful thinking and not on proven links. A more realistic and project activity related estimated number of beneficiaries is 14 million people.

[14] The implementation of DPFs in Santiago is no a consequence of this project; The SFU project concerns improved maintenance and enforcement to increase the impact of the DPF application.

[15] Bogota has 7.9 million inhabitants based on DANE-SDP, see http://www.sdp.gov.co/portal/page/portal/PortalSDP/InformacionTomaDecisiones/Estadisticas/ProyeccionPoblacion and Santiago 6.1 million see http://www.subdere.cl/divisi%C3%B3n-administrativa-de-chile/gobierno-regional-metropolitano-de-santiago

4.4. Impact on Air Pollution

The impact on air pollution until end of this phase is estimated for Bogota at around 24t PM based on a retrofit of around 1,600 to 2,000 buses. The cumulative impact is around 120t PM due to the remaining average life-span of retrofitted buses[16]. This corresponds to around 15% of public transport PM emissions of Bogota or significantly less than 1% of total PM in the city[17].

The impact in the case of Santiago depends on the number of buses with formerly faulty and now fully functional DPFs, the relative improvement factor between a faulty and a functional DPF and the remaining life-span. Around 3,000 buses are equipped with DPFs. Initial preliminary results of the field measurement indicate that around 20% of buses had a malfunctioning DPF running at efficiency levels of around 50%. Per bus the particle mass reduction is per annum around 14.5 kg[18]. Assuming that with an effective enforcement the malfunctioning rate could be reduced by 50% the impact is 2 tons of PM avoided per annum. This is due to an improved enforcement and maintenance reducing thereby the malfunctioning rate. These are not additional reductions to the ones originally calculated for the first stage of the project as latter had assumed that all DPFs work.

4.5. GHG Impact

The impact on GHG emissions includes following variables, all of which influence the result[19]:

- BC reduced per bus per annum;
- Global Warming Potential (GWP) time span used;
- GHG emissions caused by increased fuel consumption including upstream emissions;
- Remaining life-span of bus;
- Number of buses equipped with DPFs, % and level of malfunctioning rate.

Table 1: Parameters to Determine GHG Impact of Project

ID	Parameter	Value	Explanation/Source
1	BC emissions reduced per bus per annum	9 kg BC/ bus	Based on 18 kg PM emissions per bus of which 80% is reduced with DPF[20]; BC share 65% of PM mass[21]
2	Average life-time of bus in	13 yrs / 1 M km	Comparable values in Bogota and Santiago
3	GWP of BC (total effect incl. direct and Cryosphere effect)	450-1,100 GWP100 1,600-3,900 GWP20	Values for GWP100 range from 450 to 1,110 and from 1,580 to 3,870 for GWP20[22]
4	Specific fuel consumption of diesel bus	61 l/100km	Based on articulated bus; average recorded values externally verified over 8 years of TransMilenio

[16] see SDA, 2014a, chart 3 and 4
[17] SDA estimates total primary PM at 2,500t; this does not account for non-combustion related vehicular PM emissions (tire wear, brake abrasion and road dust generated) which are around 40% of total vehicle PM emissions i.e. another 400-600 tons. It also does not account for secondary formation of PM from precursor emissions such as SO_2, NO_x, VOCs and NH_3 in the atmosphere which is around 50% of total PM (variations can be large; in the US direct emitted PM2.5 accounts for 10%-70% of all PM2.5); see e.g. SDA, 2014b and N. Penaloza; W. Hodan et.al
[18] 80% of total PM emissions of around 18 kg; see SDC and MMA, 2011 3.2
[19] The project can also impact additionally GHG emissions if bus operators can operate their buses longer as this retards the introduction of new vehicles. This impact is however not included in calculations.
[20] see SDC and MMA, 2011
[21] based on Bond et. al, 2007 and Bond et. al., 2013
[22] see World Bank, 2014

5	Additional fuel consumption due to DPF	3%	Reports of bus operators in Santiago and Bogota; similar values are recorded in Switzerland
6	CO_2 emissions per liter of diesel	2,676 gCO_2/l	Based on NCV of 43 MJ/kg, EF_{CO2} 74.1 gCO_2/MJ and density of diesel of 0.84 kg/l (see IPCC, 2006 and IEA for diesel density); CO_2 emissions only; including N_2O and CH_4 emissions of diesel engines would increase this by around 23 gCO_{2e} based on GWP100
7	Upstream emission factor WTT(Well-to-Tank) diesel	25%	JRC-Study study 22%, CEC 23%, GREET model 25%, GHGenius model 29%; includes extraction, refinery and distribution

The following table shows the results of net GHG abatement caused by DPFs.

Table 2: Estimated GHG Impact of Project

Reduction	Value	Comment
GHG reduction per bus per annum	-1 to 4 tCO_{2e} with GWP100 8 to 27 tCO_{2e} with GWP20	Spread due to GWP impact range
GHG reduction Bogota total life-span project	-10,000 to 38,000 tCO_{2e} with GWP100 70,000 to 240,000 tCO_{2e} with GWP20 **Annual** for 5 years: -2,000 to 8,000 tCO_{2e} GWP100 15,000 to 48,000 tCO_{2e} GWP20	Based on retrofit of 1,800 buses and an average remaining life-span of 5 years see SDA, 2014a; 20% malfunction and drop-out rate with 50% malfunction level based on experience in Santiago.
GHG reduction Santiago per annum	600 to 1,500 tCO_2 with GWP100 2,200 to 5,300 tCO_2 with GWP20	Based on 3,000 buses, a current malfunction rate of 20% at an efficiency level of 50% and a 50% improvement of the malfunction rate due to improved enforcement and maintenance.

With a GWP100 it is possible but not sure that the BDPF actually reduces GHG emissions. The impact depends basically on the assumptions concerning the GWP impact of BC. Using a conservative approach like advocated by the UNFCCC i.e. using lower published values, the GHG impact is a slight but non-significant *increase* of GHG emissions.

Using GWP20 GHG emission reductions for Bogota are clearly positive with values between 70,000 and 240,000 tCO_2 reduced over the entire project life-span (assumed at 5 years remaining life-span i.e. annual reductions over 5 years of around 10-50,000 tCO_{2e}).

It is therefore clear that the BDPF component has a positive albeit limited short-term impact with a GWP20 and no significant GWP100 impact on climate change.

In the case of Santiago enforcement and improved maintenance does not further reduce GHG impacts beyond phase I calculated ones. However it can be said that improved enforcement and maintenance avoids 1-4,000 tCO_2 per annum (range GWP100 to GWP20).

4.6. Summary Climate Change and Air Quality Impact

The following table summarizes the potential quantitative impact of the project in Bogota and Santiago. This impact has not yet been achieved but could be realized if implementations take place as planned.

Table 3: Potential PM and GHG Impact of DPF Project Measures (in tons per annum, average values)

Project	PM 2.5 reduced (per annum)	CO_{2e} reduced (per annum)
Bogota Project	24 tons	3,000 t with GWP100 30,000 t with GWP20
Santiago Project (improved enforcement and maintenance)	2 tons	1,000 t with GWP100 4,000 t with GWP20

The PM impact especially in the case of Bogota is potentially important. The GHG impact is marginal.

4.7. Comparative Impact

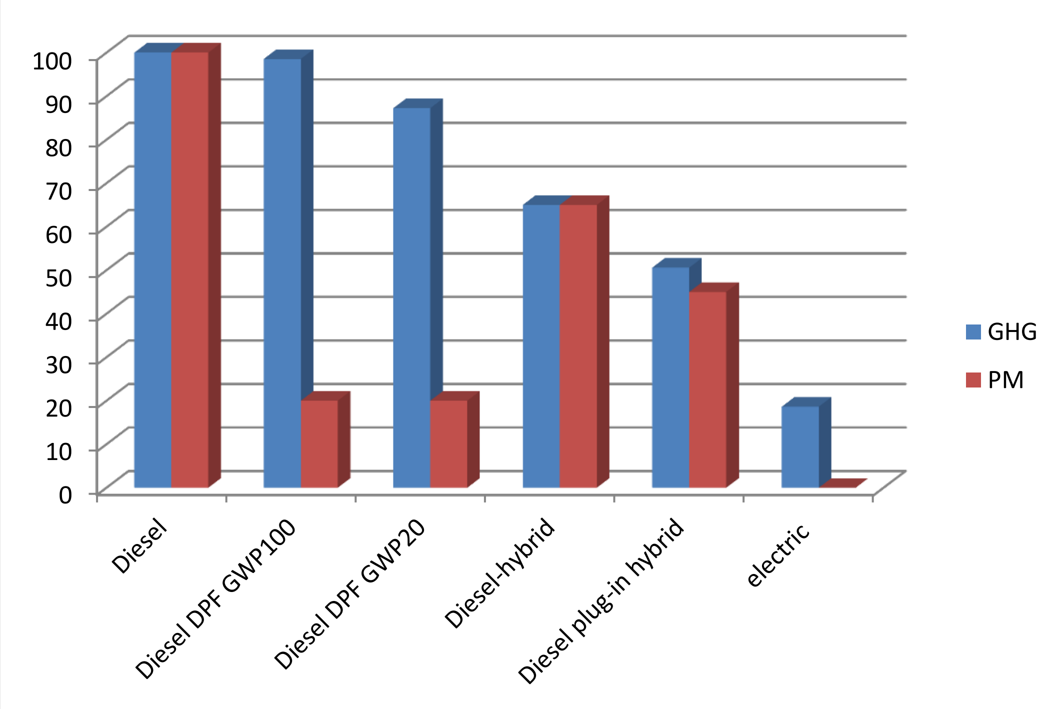
As discussed under 3.3 various alternatives to DPFs exist. A concrete and well comparable alternative which is also discussed in numerous cities is the massive promotion of alternative technology vehicles. The new public bidding documents for replacement of Phase I trunk buses of TransMilenio foresee for example diesel traction for double-articulated[23] and serial hybrid or better (full electric or plug-in hybrid) for all articulated buses. In the following a comparison is made of the PM and GHG impact between a conventional non-DPF diesel bus and a DPF diesel bus, a hybrid-diesel bus, a plug-in hybrid diesel bus, and a full electric bus (which can be based on batteries, rapid charging or electric trolleybus). GHG emissions for electricity usage include thereby upstream electricity generation emissions. The case is made for an articulated bus operating in Colombia. The following table indicates core parameters used and the graph shows the relative performance indexing a conventional diesel bus with 100. The comparison is made for conservative (lower) GHG emissions for GWP100 and GWP20 for DPF buses.

Table 4: Parameters to Determine Impacts of Bus Technologies (Articulated Bus, Colombia)

ID	Parameter	Value	Explanation/Source
1	Specific fuel consumption diesel bus	61 l/100km	Average recorded values externally verified over 8 years of TransMilenio
2	Diesel savings hybrid-diesel bus	35%	Based on externally verified data Zhengzhou, China with more than 500 18m diesel-hybrids compared to same conventional diesel buses on same routes; Bogota has with 12m hybrid buses reduction levels of 25-35%; TFL London has reduction levels of 35-45%. These are the cities worldwide with the largest modern hybrid fleet[24].
3	Diesel savings hybrid plug-in bus	55%	Based on data of Zhengzhou with 30% electric and 70% diesel-hybrid usage with on average 1.5 charges per day. Zhengzhou operates more than 1,500 plug-in hybrids.
4	Electricity consumption hybrid plug-in bus	0.6 kWh/km	Full charge for 18m bus around 60kWh.
5	Electricity consumption full electric bus	2 kWh/km	Based on full electric trolleybuses plus test rides of 18m full electric BEV (Battery Electric Vehicle) of BYD.
6	Average carbon emission factor electricity production Colombia	0.19 tCO_2/MWh	Average generation emission factor 03/2013 to 03/2014; UPME, 2015

[23] No proven alternative technology double-articulated buses with exception of trolleybuses are currently on the market. For diesel traction Euro V with DPF is foreseen.
[24] New York's hybrid fleets are 1st generation hybrids acquired 10 years ago; see Grütter, 2014

Figure 2: Comparative GHG and PM2.5 Impact of Alternative Bus Technologies



Clearly diesel-hybrids, plug-in hybrids and full electric vehicles are vastly better in GHG terms than diesel DPF buses, even based on a GWP20. In terms of PM emissions electric buses are the best followed by DPF equipped units. Looking at cost-effectiveness hybrid buses are already today, depending on bus provider and local costs, profitable solutions. Plug-in hybrids are very close to the break-even point. Also hybrids or electric buses not only have PM and GHG benefits but also significantly lower other pollutants, a lower fossil fuel consumption and lower noise levels, all important factors in a city.

5. Project Effectiveness

This section focuses on assessing to which extent intervention objectives have been achieved and what have been the major factors fostering or impeding achievements. The project effectiveness is measured at output level using the indicators defined by the project and the outcome levels as defined by the project document.

The following table relates outcomes and outputs with achievements as of early July 2015. For each outcome an overall appraisal of the level achieved as of July 2015 is made. The colour scheme is used for simplified overview and is: fully realized; partially realized; not yet realized

Table 5: Outputs and Achievements SFU

Outcome	Outputs	Indicator	Achievement
1. Know-how of MMA and MMT on international DPF policy and experience is updated	1.1. Update of know-how	a). literature submitted b). visit to CH c). DPF update report	Visit to Switzerland with 4 representatives 08/2014. Literature and update on DPF were submitted. The project however did not supply literature or material outside Swiss experience although this is deemed as relevant and the outcome states specifically *international* experience e.g. CARB released 2015 a DPF evaluation report[25] and other countries have experience with DPFs e.g. Hong-Kong[26]. **Conclusion:** The output has been partially realized by the project.
2. Santiago's DPF enforcement is improved	2.1. Introduction of PN field measurement equipment	a). equipment provided b). 150 measurements c). measurement report	Equipment has been provided and as of 07/2015 more than 200 measurements of DPF functioning had been performed. The measurement report was as of July 2015 not yet available. **Conclusion:** a) and b) realized; c not yet realized
	2.2. Assessment of DPF enforcement	Report on enforcement	Not yet realized as measurements were still being made July 2015.
3. Santiago's DPF maintenance practice is improved	3.1. Demonstration of Swiss experience and practices	Document of Swiss maintenance practice	Swiss documents and practice have been provided. The technical aspects of maintenance are included not however managerial elements of a maintenance program for large bus companies. It is questioned if technical issues are the key problem. See also chapter 3.5. **Conclusion:** Activity realized in accordance with the project document but relevance of this activity to resolve the problem is considered to be limited.
	3.2 Assessment of Santiago's DPF maintenance	Report on maintenance	Not yet realized as of July 2015.
4. Santiago's future DPF policy is outlined	4.1. Summary of key aspects of Euro V to VI	Submission of literature and documents	Presentations of Swiss experts were made and the Swiss HDV regulations were provided. However this is not considered as a sufficient literature database to take a decision to move to Euro VI. Literature and documents could include such realized by the EU or US-EPA/CARB as justification for the move forwards. Therefore this output is only considered to be partially fulfilled.
	4.2. Assessment of Santiago's future DPF policy	Report on DPF policy development	No activities have yet been performed by the project. A report would need to include inter-alia current trends of policy, technology and market development in Latin America (activity 4.2.2.) with a review of trends in major bus producer countries in Latin America (Brazil and Mexico) as well as of import trends.
5. Dissemination of Santiago's DPF program	5.1. Conference on Santiago's DPF program	Conference and number of LA participants	Not yet realized.

[25] see https://www.dieselnet.com/news/2015/05carb2.php
[26] retrofitted around 2,000 Euro II and III units with DPFs see http://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/cleaning_air_atroad.html

Discussion:

The SFU project has until now achieved of the 8 outputs 1 fully, 3 partially and 4 have not yet been realized. Of the 5 outcomes none has yet been fully completed. However this is basically due to a delay in implementation in comparison with the time-table. Basically all activities which were planned are under realization or shall be realized in the next 6-12 months. It is therefore considered as likely that objectives will be achieved.

The major factor for the achievement of objectives is considered to be the good technical assistance given by Swiss experts and the high level of know-how and experience of the Chilean partners.

The major problem encountered is that reports and know-how is too much Swiss focused. Whilst the Swiss DPF experience is valuable, other cities and countries have also significant experience with DPFs. This refers e.g. to the outcome 1 (know-how update on DPF) and outcome 4 (future policy). Lessons learned from such experiences could be helpful for a cost-effective enforcement. The issue of Euro VI introduction should also be assessed less ad-hoc and Swiss-centered and should include the elements of diesel fuel quality, bus manufacturing trends in Latin America and the cost-effectiveness of measures. In the area of maintenance of large bus fleets Switzerland might contribute to some experience specifically concerning DPFs but has probably limited relevant experience concerning the establishment and management of a maintenance system for large bus fleets under sever operational constraints.

Table 6: Outputs and Achievements BDPF

Outcome	Outputs	Indicator	Achievement
1. DPF retrofit pilot test with 14 buses	1.1. Consolidated test procedure	a). Report on test procedure b). Definition of performance criteria	Realized see BDPF Infome Tecnico 1
	1.2. PPP between gov., bus operators and DPF providers	a). PPP established b). Commercial agreements signed	Realized
	1.3. DPF test preparation	Vehicles selected	Realized
	1.4. Pilot test with 14 buses	Test report	Only 2 buses made the full test; in 4 buses a DPF was installed but malfunctioning occurred which could not be resolved by the DPF producer and finally the DPF was retired. The pilot test only shows that DPFs can work on well-maintained Euro III trunk buses (as both DPF units were this type of bus). At the same time on 4 other buses DPFs led to serious operational problems even though buses had been considered as appropriate and well maintained by DPF producers thus poising questions concerning the applicability of the technology. The pilot test did not comply with the objective of creating a baseline. The original target had been to include all bus categories as well as Euro II, III, IV and V units. Of the 5 bus categories only 1 was included and of 4 Euro standards run by TransMilenio only 1 was included. Therefore the pilot test

			cannot claim to have shown that DPFs actually work at the altitude and operational conditions of Bogota nor do they show that DPF retrofit is an economically sound approach for buses as used in the transport system of Bogota. Reasons why so few buses participated are resistance of operators, bus manufacturers and lack of assistance of DPF manufactures pointing to deficient stakeholder coordination and design clarity.
2. Approval scheme for DPF retrofit designed, validated & introduced	2.1. Approval scheme designed & validated	Report regarding test procedure	Approval scheme exists see SDA, Anexo 2.2 Lineamientos y recomendaciones para establecer un esquema de aprobación local; Documento técnico de soporte
	2.2. Approval scheme introduced & implemented	Regulation proposal	The local approval scheme has been implemented. 1 DPF producer as of 06/2015 has been approved and 2 are in the process to get approved. Due also to only 2 successful trials in the pilot tests the scheme lacks approved DPF manufacturers.
3. DPF implementation targets are legally introduced	3.1. Interchange with Chile and Switzerland	Visits to Switzerland and Chile	Realized and recognized by participants as of being very informative and helpful.
	3.2. Introduction of implementation scheme	a). Cost-effect. tool b). Policy report	Cost-effectiveness tool was introduced. Resolution 00123 of 6.2.2015 establishes the legal base for retrofit of buses with DPF.
	3.3. Health benefits DPF implementation known	a). WHO model b). Health workgroup	Not yet realized
4. The enforcement of the retrofit program is prepared	4.1. Interchange with Switzerland and Chile	Visits to CH and Chile	Realized
	4.2. Consolidation of DPF enforcement	a). technical report b). regulation for inspection c). acquisition of instruments	The CALAC progress report 2 cites this part as realized as of 01/2015 with documents in reports BDPF 4, 6 and 7. Activities related to this output based on the project planning document are: a). an assessment of the DPF enforcement scheme; b). Identification of needs for capacity building; c). Identification of needs for equipment; d) Proposal for DPF enforcement scheme. Discussions on enforcement have been realized and a write-up of the discussion has been produced in the BDPF reports. However there is no comprehensive report on enforcement including an analysis of different enforcement paths, the legal situation, practical implementation aspects, required resources, involved stakeholders, risks and timeline. Advisory services are primarily an ad-hoc information interchange. This should be complemented with sound documentation. **Conclusion:** Activities only realized at an initial but insufficient stage.
	4.3. Best practice maintenance of DPF is promoted	a). DPF maintenance guideline b). workshop operators c). Databank on retrofits incl. failures	Not yet realized as buses have not yet been equipped with DPFs. First steps of discussing the importance of maintenance were realized during the visit in Switzerland but no further steps have yet been taken.
	4.4. DPF implementation of 300 buses	a). Databank b). workshop operators	Not yet realized. Based on the resolution 00123 around 1,500 buses need to be equipped with DPFs until end 2016; the timeline of the resolution will most probably not be met.

5. Emission reductions are calculated; exchange on emission factors	5.1. Interchange of experiences with Chile	Visit report	Visit realized
	5.2. Emission reductions of different DPF scenarios	Calculation report	A report was realized; see SDA, Programa BDPF, Documento tecnico de soporte, 2014
6. Dissemination of the BDPF	6.1. Seminar on BDPF	Conference doc.	Not yet realized
	6.2. Negotiations with bus manufacturers	Meetings held with bus providers	Not yet realized

Discussion:

Of the 17 outputs 10 have been realized 2, partially and 5 not yet. 3 of the outputs are however repetitive (visit/interchange with Switzerland). Looking at the outcome level the results are:

- The pilot test (outcome 1) was realized but not in a satisfactory manner. Only 2 buses have successfully completed the pilot stage (both articulated Euro III). The pilot test cannot claim to show that DPFs are viable at the altitude of Bogota and a cost-effective solution for TrasnMilenio buses.
- The outcome 2 has been fully achieved and local regulations are in force concerning application of DPFs. However it is unclear if and when the regulation will actually be enforced and implemented. The regulation has also some serious shortcomings being basically:
  - The cost-effectiveness of retrofitting Phase I and partially Phase II buses is not given. Retrofitting buses with a DPF with a remaining life-span of 5 years or less is not an effective strategy (see chapter 6). The DPF retrofit strategy should be directed towards retrofitting Euro IV and V buses which have DPFs included within operational contracts with TransMilenio and which will remain for a significant remaining period on the road. Euro II and III buses will to a large extent be replaced in the next few years.
  - The technical viability and the specifications of DPFs to be used in Bogota have not been sufficiently clarified with the pilot test. Due to engine types, load factors and altitude conditions of Bogota DPF filter sizes and types might need to be adjusted.
  - The regulations state that DPF filters need to be certified by FOEN or CARB. The exclusive formulation of this paragraph could be problematic due to infringing free competition and could thus be questioned e.g. by DPF producers from other countries (e.g. Korea). It would be recommendable to have an open formulation in which DPFs must supply a certification from CARB or FOEN *or equivalent*.
- Outcome 3 with economic and health tools has been partially realized. The economic part has been covered but not yet the health tool.
- Outcome 4 focusing on enforcement and maintenance is to a large extent incomplete. The experience of the SFU component could form the base for an effective enforcement and maintenance advisory service.
- Outcome 5 has been realized, although the cost-benefit calculation has some deficiencies (see chapter 6.2. for comments).
- Outcome 6 has not yet been realized.

Overall objectives in the regulatory part have been achieved. However the BDPF lacks conceptual clarity. It is questioned if the Decree in its current form can and will be implemented. It is even questionable if it is useful to implement it in the current form due to limited cost-effectiveness and technical difficulties.

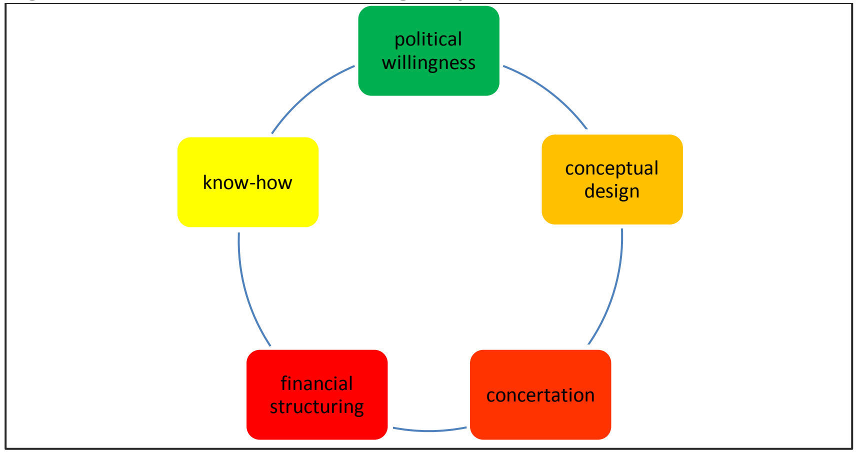
The pilot testing has clearly not led to the expected results. A better planning and closer follow-up at this stage would have been required. The attainment of project objectives and actual implementation in its current form is considered as unlikely.

Major positive factors influencing the achievement of goals have been the technical assistance of Swiss experts and the field visits. However the technical complexity and the efforts required have been under-estimated. Also the political context and the timing of the DPF project have not been taken sufficiently into consideration. TransMilenio and its operators are currently under intense pressure from three major areas:

- The transformation from a separate transport system with basically trunk buses to the SITP including all public transport operators is a huge step requiring significant managerial, technical and financial resources. This involves moving from less than 10 to dozens of operators, some of which lack the organization qualities to be efficient operators and from around 25% to 100% coverage of public transport trips.
- Intense financial pressure on the system which hovers on bankruptcy. The pressure on reducing tariffs from the Municipality aggravates this problem.
- The city has a clear objective to move towards 0-emission transport. TransMilenio has already the largest fleet of hybrid buses in Latin America and is testing together with the IADB various types of electric buses. Mid 2016 the public bidding process will start for replacement of Phase I buses where articulated buses shall be as minimum hybrid with additional points given for 0-emission autonomies like plug-in hybrids and electric units.

The DPF program is therefore not on the current priority list for TransMilenio, which also considers that the focus should rather be on OEM-equipped DPF buses for the next stage and on retrofit of Euro IV and V buses where contractually such obligations already exist. Coordination with a core actor (TransMilenio) and its operators has been insufficient thus jeopardizing the pilot tests as well as the project implementation. The following figure identifies the core factors which are considered to be crucial for success of a BDPF project.

Figure 3: Core Factors Influencing Project Success



Colour scheme: "green" = condition fulfilled; "red" = condition not met; colours in between mean partial fulfilment

Political willingness refers to decision makers being interested and willing to take action and to implement policies even against resistance of certain parties. The political willingness on behalf of the city authority was clearly given and regulations concerning usage of DPF were issued.

Conceptual design refers to embedding the activity within a long-term strategy. City authorities positioned DPF within a clean air strategy including also other components. However the inter-relation between DPF and emission regulations and new technology strategies was not considered sufficiently. A strategy needs to include the medium and long term perspective of 0-emission vehicles and Euro VI, a path how to clean-up Euro IV and V buses and a short-term strategy for elder buses. Different instruments need to be assessed against a cost-benefit benchmark. The project clearly lacks conceptual clarity.

Know-how refers to technical know-how including measurement and test methods and regulatory issues. These were well covered by the project. However the pilot test lacked scientific clarity and rigorousness. Having usable results of just 2 buses after 1.5 years is not sufficient and central questions of appropriateness and potential problems of DPFs in buses as used in Bogota under the driving and altitude conditions of Bogota have not been clarified in a satisfactory manner.

Financial structuring refers to a concept on how the measure shall be financed. Measures such as DPFs involve a cost which must be borne by one or various involved parties. Regulations without clear financial structuring are often doomed to be paper-tigers. The project lacks a financial structuring.

Concertation refers to including all relevant stakeholders in the process and to concentrate project efforts with other on-going activities. The project clearly has a weak spot in this part and is more or less an isolated effort of SDA. The municipal mobility secretariat was scarcely involved, TransMilenio only partially, and operators never came on board which is reflected in their blocking of pilot tests. Also DPF producers lacked interest reflected in the fact that only few have come forward to get their product approved. At a national level no inclusion of other relevant authorities took place such as for example the Ministry of Environment or UMUS (the entity of the Transport Ministry in charge of sustainable urban mobility). The inclusion of national authorities could have been interesting as other major cities in Colombia such as Cali, Medellin, Bucaramanga or Pereira have similar problems and also run BRTs comparable to TransMilenio[27] which would allow for interchanging experience and expanding project scope and impact whilst also attracting potentially climate finance.

Table 7: Outputs and Achievements CA

Outcome	Outputs	Indicator	Achievement
1. Facilitation of regional participation at key events in Santiago, Bogota and	1.1. Visit of other delegates during Bogota visit to Chile	Participants from other cities	Progress report 2 states the output as realized. A visit of officials from Bogota took place in Santiago - however this forms part of the outcomes of the BDPF component. The CA component states the participation of *other* cities (beyond Bogota). A Mexican delegation visited Santiago in July 2015. Originally participants from 3 cities (Lima, Sao Paulo and Buenos Aires) were envisaged, therefore partial realization of this output.

[27] the cities of Medellin and Cartagena have not been included as both use gaseous fuels for their BRT systems

Switzerland	1.2. Participation of delegates at the Bogota DPF conference	Participants from other cities	No conference yet realized in Bogota and therefore not yet realized.
	1.3. Participation of delegates at the Chilean DPF conference	Participants from other cities, Santiago authorities and IOs	No conference yet realized in Santiago and therefore not yet realized
	1.4. Participation at the ETH conference 2014	Participants from other cities, Santiago authorities and IOs	At the ETH conference 2014 and 2015 2 respectively 1 participant from the National University of Bogota (UNAL) participated. At the VERT forum 2014 and 2015 1 participant from SDA Chile assisted. Other cities did not participate albeit being invited. The output has therefore been realized partially.
2. Exploration of policy context, interest and possibilities for DPF replication in associated cities	2.1. Facilitation of Chilean advisory support	2 visits to Lima and 2 visits to Buenos Aires	1 visit of the Chilean project team member to Mexico City 03/2014. MMA mentioned that it or other government agencies would like to have been involved more in advisory support and not just the Chilean project team member (Geasur). A delegation of Mexico visited Santiago and interchange of experiences was made which was considered very fruitful. The output has been realized partially.
	2.2. Chilean back-up support is facilitated	Workshops in Lima and Buenos Aires with participation from Santiago and Bogota	No workshops in other countries with the participation from Santiago and Bogota took place. A Mexican delegation visited Chile already captured under outputs 1.1. & 2.1. while this output is the participation of Chilean and Colombian delegations at workshops in other countries to facilitate DPF application. The output has not been realized.
3. Establishment of a city alliance of pioneering cities on DPF	3.1. Facilitation of experience interchange South-South between cities	Visits from Santiago to Bogota and vice-versa	A delegation from Bogota was in Santiago[28]. A SUBUS representative was also in Bogota to report on maintenance practices and DPF. The output has been partially realized (no other visits apart from SUBUS to Bogota)
	3.2. North-South experience exchange between cities	Visit from Swiss city to associated cities	Not yet realized
	3.3. Establishment of a city alliance for DPF promotion	MoU signed with minimum 3 core cities	Not yet realized (no MOU, no formal alliance has been established)
	3.4. Strengthening of liaison with CCAC	Contacts to focal points of CCAC	Not realized. SDA and other partners have no contacts and links with CCAC. No documentary evidence of uploaded reports, contacts, information exchange or strengthened liaison.
4. Advocacy & policy influence are optimized; platform is established	4.1. Design and establishment of platform	Concept paper on platform	A draft concept paper on the platform was made (annex 9 of BDPF report 7). However the concept paper is basically a description of a website and not a concept paper. A concept paper would require an assessment of the objectives of a platform, analysis of alternative approaches to structure a platform incl. an assessment of existing city as well as technical information platforms, justification of the chosen approach, required resources,

[28] In various parts the CA outputs repeat outputs already stated in the BDPF program i.e. the same activity is reported in both components.

			organizational and financial structuring incl. technical and financial sustainability, risks and potentials and a timeline for implementation. Conclusion: No conceptual design and not yet established. Therefore output not yet realized.
	4.2. Quarterly info. updates	Quarterly reports	No platform untill now and therefore not yet realized.

Discussion:

The CA component focuses on other Latin American cities. N-S and S-S interchange of experiences between Santiago, Bogota and Switzerland are already included in the SFU and BDPF components (see e.g. output 1.1. in SFU and outputs 3.1., 4.1 and 5.1 in BDPF). The focus of the CA component is **regional** participation (see outcome 1) and **replication** in associated cities (outcome 2). In this context the only activity and the only contact to the moment are with Mexico with a Mexican delegation visiting Santiago July 2015. Visits of the Bogota delegation in Chile and of a representative of the Chilean bus operator SUBUS in Bogota (S-S interchange) as well as visits of Santiago and Bogota to Switzerland (S-N interchange) have been appreciated and are considered as very helpful. However these are basically parts of the SFU and BDPF components. Therefore with exception of the Mexican delegation visiting Chile July 2015 no regional participation and no replication has been realized or achieved. Therefore the project has not achieved to the moment any of the outcomes of this component.

The question can be raised if interest for this type of project lacks. An interesting side-note in this respect is that Chile has decided **not** to require either for DPF-fitted buses or for Euro VI in its recent public bidding documents for new buses for public transport services outside Santiago de Chile. This albeit the wide experience with DPF fitted buses in Santiago. The focus on DPF retrofit might also be problematic due to involved complexity and costs. The Mexican delegation e.g. remarked that whilst retrofit might be an option for buses with a remaining long life-span, the focus would be on Euro VI for new units. Also TransMilenio and local operators in Bogota prefer to focus on OEM-equipped DPF units.

The communication and outreach strategy seems to be centred on establishing a property website and loading up reports on such a site. Contacts with organizations already involved in sustainable transport including CCAC, C40, SLoCaT etc. are not actively pursued. This is also questioned by the Mexican representatives (specifically the contact to C40). Many major cities in Latin America are already actively involved in climate change, sustainable transport and comparable initiatives and establishing an additional network is of little use, whilst a strategy to empower with concrete information, reports and documents established networks and communication channels could be far more cost-effective and with far more impact.

6. Project Efficiency

6.1. Project Implementation Efficiency

Overall the outputs seem in a reasonable relation to the resource inputs as presented in the planning workbook. In the component CA which has as objective to build up capacities of other LA cities the distribution of resources is however questioned: 35% of resources are used for the Swiss advisory team and in total 60% of all resources go to the Swiss/Chilean advisory team i.e. a maximum of 40% of resources actually goes to other LA cities. This relation seems to be a bit tilted considering the focus on other Latin American cities and S-S know-how transfer.

As the project is de-phased to a large extent no statement on actual efficiency execution levels can be made at the current moment. A simple comparison of actual expenses and delivered outputs to the moment is not considered as useful as many tasks have begun, with the corresponding expense implications, but the outputs have not yet been fully completed.

The question of efficient project implementation is also related to the implementation status which has suffered considerable delays. The project has clearly not achieved the objectives on time. By July 2015 the project should have finished the phase and have achieved all activities. As of today the project seems to be around 12 months delayed in implementation i.e. the current phase will be completed potentially mid 2016 instead of mid 2015. The following points show the delays per component:

- SFU activities only started August 2014 after signature of the project document by the Chilean authorities i.e. with a time-delay of around 8 months. The mission of the Swiss advisory team, originally planned for mid 2014 effectively took place July 2015. The last activity in the timeline namely the Santiago DPF conference is currently foreseen for November this year. Therefore compared to the time-schedule the project has a delay of minimum 6 months but more realistic is to assume a completion of all outputs in the first semester 2016. The original planning was too optimistic and lacked to take into account obvious implications of Chilean elections.
- The BDPF started on time. Delays have resulted primarily in the pilot test and the practical implementation whilst the legislative part proceeded swiftly and on-time, due to considerable local pressure. Pilot test delays are not surprising considering the fact that bus maintenance is poor, especially of zonal buses being integrated progressively into TransMilenio, and the foreseeable resistance of bus operators to cooperation[29] i.e. planning was unrealistic and not in accordance with local circumstances. The structure of implementation has changed due to the legal requirements for DPF which have been issued prior the planned trial phase. Based on the Resolution 00123 by September 2015 a significant portion of the trunk fleet should be equipped with DPFs and by December 2015 also a certain amount of the feeder or zonal fleet should be equipped with DPFs. This means that effectively activities under Output 4.4 which assess experiences on enforcement and practical implementation, previewed for early 2015, can only be implemented early 2016.

[29] Logical due to the fact that bus operators anticipate additional costs and requirements without clear finance.

- The CA component focuses on other Latin American cities. Concerning the city alliance part the strategy has seemingly been to first provide for sound technical documents and then start with the platform. This approach is not considered to be very effective nor efficient. The outreach concept and a critical discussion of the establishment of a new city alliance as well as a website could have been done prior to having final technical inputs. Overall the time-delay of this component is minimum 1 year.

6.2. Efficiency of Project Approach

The efficiency of the project approach refers to two fundamental questions:

1. Have measures a positive cost-benefit?
2. Are measures compared to alternatives with the same outcome cost-efficient?

Cost-Benefit

The economic analysis used is based primarily on a damage cost technique. This is a cost-benefit appraisal comparing abatement costs with avoided damages (also called benefits). Latter are primarily monetized health avoidance costs. Measures with a negative cost-benefit should not be taken as from a societal point of view economic resources would be wasted.

The primary target of the project is PM reduction and the secondary GHG reduction. For both elements societal costs have been included in calculations. The GHG impact depends on the GWP used (20 or 100). Calculations have been performed for Bogota, as here a full implementation takes place whilst Santiago is basically an optimization of efforts. The following table shows parameters used for calculations.

Table 8: Parameters to Determine Cost-Benefit of DPF Project in Colombia

ID	Parameter	Value	Explanation/Source
1	Lifetime average cost of DPF incl. maintenance per bus	18,000 USD	Based on DPF cost-effectiveness tool of project
2	Additional fuel cost per bus lifetime	5,400 USD	Based on 61 l/100km; 3% additional fuel consumption; 0.77 USD/l fuel cost; 5 year remaining lifespan; annual mileage of 77,000 km; Data sources see table 1
3	PM reduction per bus lifetime	73 kg	Based on 18 kg PM per bus per annum and 80% reduction with 5 years remaining lifespan; Data sources see table 1
4	CO_{2e} reduction per bus lifetime	8 tCO_{2e} GWP100 88 tCO_{2e} GWP20	Based on 9 t BC per bus per annum and simple average lower/upper value per GWP minus GHG emissions due to additional fuel consumption; data sources see Table 1
5	Damage cost PM Bogota	330,000 USD/t	Based on 765 MCOP/tPM and an exchange rate of 2,350 COP per USD; see SDA, 2014a, p. 48
6	Social cost of CO_{2e} emissions	40 USD/t	Based on http://costofcarbon.org/faq used by various countries; See also World Bank, 2014; The value is very much dependent on the discount rate chosen[30].

Above listed costs do not include additional costs due to additional maintenance of buses required prior DPF installation or usage of higher quality oils as recommended by DPF manufacturers as such

[30] see e.g. http://www.epa.gov/climatechange/EPAactivities/economics/scc.html for 2015 SCC (social cost of carbon) values between USD 12 per t with a 5% discount rate and 61 USD with a 2.5% discount rate

measures tend to also have a positive fuel consumption impact and can thus be considered as zero-cost from a lifetime perspective.

The damage cost estimated for Bogota is considered as reasonable and probably rather at the higher end. The UK Government for example has estimated damage costs caused by PM at USD 380,000 per ton for inner London (highest value of the UK) or USD 120,000 per ton for large urban zones[31].

The cost-benefit figure only for PM based on above values is around 200 USD per bus entire lifetime or around 350,000 USD entire life-time of project and all retrofitted buses[32]. Including the social cost of carbon the net benefit increases to 500 USD per bus entire lifetime with GWP100 (total project entire lifetime USD 0.9 MUSD) and 3,700 USD per bus with GWP20 (total project 6.7 MUSD). The average estimated cost-benefit of the project is therefore positive i.e. costs are lower than benefits. However the margin is slim and the project has a certain probability of having a negative relation between benefits and costs. The safety range of the calculated PM damage cost is ±13% and the safety range of PM reductions per bus also ±13%[33]. Taking the lower safety range (conservative approach) the cost-benefit of the project is negative: the project would cause additional costs of between 3.6 and 9.4 MUSD for the entire life-span (lower value for GWP20 and higher value for GWP100). Also if the remaining life-span of buses is just reduced by less than 1 year the project will in all cases have a negative cost-benefit. This clearly points to the necessity of assessing more in depth the costs and benefits of DPF retrofits before venturing into mass-scale promotion. It also shows that retrofit of buses with less than 5 years remaining life-span is a non-effective measure and to be on the save side only buses with a remaining life-span of 8 years or mode should be equipped with DPFs as only in this case the cost-benefit is in all cases positive.

Important in this respect is that this refers to the retrofit of DPFs. Usage of DPFs on new buses or usage of Euro VI units should have a better cost-benefit relation due to the remaining life-span. This highlights a clear strategic element which has not been sufficiently taken into account by the project: Retrofit of DPFs is potentially a questionable measure based on cost-benefit analysis whilst the promotion of DPF equipped new buses has a clear positive impact.

Relative Cost-Efficiency of Measures

Relative cost-efficiency refers to comparing the cost of the measure taken with alternative options i.e. alternative vehicle technologies, reducing PM from brakes, tire abrasion, industrial and commercial sources etc. A measure can have a positive benefit-cost relation but still not be the most cost-efficient option.

For PM the location of the reduction is relevant as damage costs depend on concentration levels of pollutants and population exposure levels. For GHG the site of emissions is however irrelevant – at least for the environment[34].

A good comparison base for alternative cost levels are market prices. Currently for GHG reductions world-market prices for certified emission reductions are lower than 1 USD/tCO_{2e} and EU trading

[31] central values; see https://www.gov.uk/air-quality-economic-analysis re-calculated to USD 2014
[32] estimated at 1,800 units
[33] see SDA, 2014a, p. 48
[34] For BC however local differences do exist as the CO_{2e} impact depends on the site of release of BC.

prices are at 9 USD/tCO_{2e}[35]. Therefore obviously there are still many options available currently in the market which can generate emission reductions of CO_{2e} at prices significantly lower than the social cost of carbon.

For PM it is more difficult to find benchmarks as costs are site specific. The marginal abatement cost of the project is slightly over 300 USD per kg of PM. Marginal abatement cost curves for PM have been constructed for various Australian sites, including Sydney, which point to many options with marginal abatement costs of less than 200 USD per kg of PM. Hybrid and plug-in hybrid buses e.g. have a negative or near-zero marginal abatement cost for PM – electric buses on the other hand have an abatement cost of more than 4,000 USD/kg i.e. would be far more expensive as option for reducing PM than the usage of DPFs. The abatement cost per kg PM of DPF can be lowered to around 200 USD/kg by installing DPFs on new units instead of retrofitting existing units with a limited remaining life-span.

Above figures show that retrofitting of DPF tends to be a costly measure compared to alternative abatement options. Fitting DPF to new buses has much lower costs. Under the header of cost-efficiency the retrofit approach is therefore questioned.

7. Project Sustainability

The components SFU and BDPF are both well embedded within the governmental entities responsible for issuing and enforcing vehicle emission standards including DPFs. in both countries a legal obligation for the retrofit of buses exist. Enforcement is also a core element of both programs. The DPF program has basically been instrumental on the know-how transfer part and not on financing actual implementation, which is paid by the private sector or indirectly by public transport users. Benefits of the retrofit DPF program will therefore be sustained without problems once the project ends. Also competence gained on the importance of DPF for new vehicles is well embedded in the institutions and sustainability of long-term actions like the more rapid introduction of Euro VI standards is given.

Concerning the platform no concept and clear strategy exists to the moment. The idea is a web-platform. Ideas of a "Circle d'Air" like in Switzerland are expressed without a clear concept. A useful website requires continuous update, new inputs, active users and a clear financial concept. None of these elements are given. The CA component as currently devised is considered to be non-sustainable. The sustainability is neither given on the contents part (who will supply under which motivation new contents and who will realize QA of such contents and create value added?) nor on the financial part as no additional financial resources have been identified or tapped. A sustainable strategy in this part could be to focus on using existing platforms actively and shaping and influencing these e.g. CC40, CCAC, Dieselnet etc. or even updating and filling with contents and links the Wikipedia site on DPFs. Next to websites many other information and knowledge exchange platforms exist today which could be tapped e.g. like-minded groups e.g. based on Facebook[36] or WhatsApp

[35] https://www.eex.com/en/market-data/emission-allowances/spot-market/european-emission-allowances#!/2015/07/02

[36] as example truckers and logistic forwarders in Vietnam use Facebook groups as site for reducing empty backhaul by matching truck offer with transport demand.

popular in Latin America or also e-learning platforms. In principle a sustainable dissemination strategy is probably more successful by using multiple existing platforms as well as multiple existing channels and feeding them with inputs and concepts plus gearing them partially towards the project goal instead of new stand-alone one-source sites. Obviously this requires a different approach than creating another new website (of which already more than 1 billion exist…) which will cease active live some months after SDC finance dries out.

8. Conclusions and Recommendations

Following main conclusions are reached:

1. The focus of the project on DPF is a major strength. However a focused approach needs to consider carefully if the instrument is applicable and cost-effective under given circumstances. This was not sufficiently taken into account by the project.

2. The technical assistance provided by the project is appreciated by the counterparts and considered of good quality. Reports provided could be more comprehensive and should include also relevant experience outside Switzerland.

3. The reduction of PM and GHG emissions is a high priority in concerned cities and the project is therefore working in a relevant context. The project is also well embedded within national and local strategies to combat PM and has been proposed by the local entities.

4. The project focus on DPF with a significant part on retrofit was warranted based on the local request. However a simple replication of this end-of-pipe and technically relatively complex and costly approach is not considered as useful as other sustainable transport strategies can have a broader and more sustained impact with a potentially better cost-benefit relation.

5. All project components have a time-lag in implementation and will presumably finish their activities mid 2016.

6. The SFU component is well structured and activities to comply with all outcomes are underway.

7. Within the BDPF component the specific technical know-how given by project experts and the site visits are appreciated. However the project has shortcomings on the conceptual and strategic level. Problems include:
    a. The pilot test does not prove the applicability and usefulness of retrofitting DPFs in Bogota.
    b. The focus of the DPF regulation is on retrofitting elder buses with a limited remaining life-span.
    c. The cost-benefit of the measure is potentially negative and the impact limited.
    d. The initiative comes at a time when TransMilenio and its operators are undergoing a massive re-structuring and are aiming at introducing on massive scale low and 0-emission vehicles thus limiting availability of resources for additional activities.

A more promising DPF strategy would be to focus on new buses (TransMilenio is currently preparing the tender documents) and on retrofitting Euro IV and V buses with a remaining life-span of minimum 8 years.

8. The CA component of the project has not been active apart from a visit of the Mexican delegation. The concept and replication approach of the component is not convincing. The impact and sustainability of establishing a website and interchange site is questioned, especially in light of other existing platforms and forums where DPF could play a prominent role e.g. C40, CCAC but also specific transport platforms like Dieselnet, SLoCaT etc.

Ideas concerning the next phase are given in a separate document. Therefore recommendations are only formulated in an abbreviated manner:

1. Replication of the project is only useful under very specific circumstances. In general the promotion of low-sulphur fuels together with Euro VI or comparable standards is considered to be a more sustainable and techno-economical more sound strategy than retrofitting existing fleets.

2. Considering the higher degree of complexity of introducing DPFs with off-road machines and the problems already encountered with fostering the DPF retrofit in buses it is not recommended to enter this field. In exceptional cases as follow-up of an existing activity as is the case in Santiago this might be useful but it is not recommended to follow this path with Bogota or other cities, especially whilst DPFs with buses has not yet been established.

3. The CA component should be re-structured with a focus on usage of existing platforms and channels.

4. Extend and expand slightly the first phase of the project until end 2016 so as to complete all planned activities in the three components, restructure the CA component and include some elements of off-road machinery DPF for Chile.

5. Not realize a second phase of the project. To expand the project scope to other topics of sustainable transport within the area of climate change and air pollution control is not recommended. DPF is a clear-cut technical end-of pipe solution whilst other elements of sustainable transport require a different team with other competences. Also taking up new topics will change project objectives and a successful implementation will hardly be possible within 1-2 years thus requiring additional phases thereafter. The relation between other sustainable transport solutions and DPF is also not given - therefore it would make more sense to design a new program under the header of sustainable transport with the focus on solutions which reduce air pollution as well as GHG emissions within cities than to include ad-hoc within a DPF program other components of sustainable transport.

Annex 1: Summarized Logical Framework of Project

Table A1: Logical Framework Project Component Santiago DPF Follow-Up (SFU)

Objective	Outcomes	Outputs/Activities
BC emission reductions and benefits of Santiago's DPF program are fully achieved by optimized enforcement, improvement of DPF maintenance practice and further development of DPF policy	1. Know-how of MMA and MMT on international DPF policy and experience is updated	1.1. Update of know-how on international DPF policy and experience to be attained through the compilation of relevant Swiss and international reports on DPF and a study tour to Switzerland.
	2. Santiago's DPF enforcement is improved	2.1. Introduction of PM field measurement equipment incl. equipment acquisition, training, realization of 150 field measurements, data compilation and data assessment through Swiss advisory team. 2.2. Assessment of ongoing DPF enforcement incl. a review of existing performance, site visits by Swiss advisory team and a report on the enforcement performance with recommendations for optimization.
	3. Santiago's DPF maintenance practice is improved	3.1. Demonstration of Swiss experience and practices based on a compilation of relevant documents and a study tour to Switzerland. 3.2 Assessment of Santiago's DPF maintenance practice based on a compilation of the guiding tools for DPF maintenance, site visits, a workshop with bus companies and a report of the Swiss team.
	4. Santiago's future DPF policy is outlined	4.1. Summary of key aspects of Euro V to Euro VI standard based on a compilation of documents. 4.2. Assessment of Santiago's future DPF policy based on an assessment of current policy trends, technology and market development in Latin America, an identification and discussion of options and a report of the Swiss team.
	5. Dissemination of Santiago's DPF program and results	5.1. Conference on Santiago's DPF program for Latin America.

Table A2: Logical Framework Project Component Bogota DPF (BDPF)

Objective	Outcomes	Outputs/Activities
BC emissions of the integrated public transport system are significantly reduced by the application of DPF	1. DPF retrofit pilot test with 14 buses	1.1. Consolidated test procedure incl. equipment acquisition, know-how transfer and a study tour to Santiago. 1.2. Establishment of a PPP between government, bus operators and DPF providers. 1.3. DPF test preparation incl. performance criteria, legal requirements and a fleet analysis. 1.4. Pilot test with 14 buses realized including a technical report.
	2. Local approval scheme for DPF retrofit is designed, validated and introduced	2.1. Local approval scheme is designed and validated. 2.2. Local approval scheme is legally introduced and implemented incl. the recognition of DPF test results and the local approval of successful DPF providers.
	3. DPF implementation targets are legally introduced	3.1. Interchange with Chile and Switzerland based on policy tours. 3.2. Definition and introduction of implementation scheme incl. a cost-effectiveness tool, fine-tuning of priorities, a regulation proposal and a proposal for DPF retrofit requirements for future bus concessions. 3.3. Health benefits of DPF implementation are assessed and results disseminated.
	4. The enforcement of the retrofit program is	4.1. Experience interchange with Switzerland and Chile. 4.2 Consolidation of DPF enforcement scheme incl. the identification of

	prepared	capacity building needs, instrumentation and a DPF enforcement scheme proposal. 4.3. Best practice maintenance of DPF is promoted incl. guidelines on retrofit and maintenance of DPFs, a workshop with bus operators on DPF maintenance and the identification of training needs of bus operators. 4.4. DPF implementation of 300 buses including the analysis of enforcement, practical experience and a workshop with bus operators on the practical experience.
	5. Emission reductions are calculated; experience exchange on emission factors is realized	5.1. Interchange of experiences with Chile. 5.2. Technical report on emission reduction of different DPF scenarios is elaborated.
	6. Dissemination of the BDPF	6.1. Seminar on BDPF including the establishment and update of a webpage on DPF within the SDA website. 6.2. Business negotiations with bus manufacturing companies.

Table A3: Logical Framework Project Component City Alliance for DPF (CA)

Objective	Outcomes	Outputs/Activities
Bring forward and support initiatives of LA cities with the aim of introducing DPFs and build up capacities to deal with and measure ultrafine particles and strengthen the alliance between pioneering cities developing DPF programs.	1. Facilitation of regional participation at key events in Santiago, Bogota and Switzerland	1.1. Visit of other delegations during the Bogota delegation visit to Chile (Buenos Aires, Lima and Sao Paulo). 1.2. Participation at the Bogota DPF conference with delegates from Santiago, other cities as well as international organizations (WB, UNDP, IDB, GEF). 1.3. Participation at the Chilean DPF conference with delegates from Bogota, other cities as well as IOs. 1.4. Participation at the ETH conference with delegates from Chile, Bogota and other cities.
	2. Exploration of policy context, interest and possibilities for DPF replication in associated cities	2.1. Facilitation of Chilean advisory support to identify potentials for replications incl. visits to Lima, Buenos Aires, Sao Paulo and a report on the possible replication of the Santiago and Bogota DPF program. 2.2. Chilean back-up support is facilitated.
	3. Establishment of a city alliance of pioneering cities on DPF	3.1. Facilitation of experience interchange South-South between cities based on study tours. 3.2. North-South experience exchange based on direct contacts and information exchange with a Swiss city. 3.3. Formal establishment of a city alliance incl. MoU with a Swiss city, Bogota and Santiago with the possible inclusion of other cities. 3.4. Strengthening of liaison with CCAC.
	4. Advocacy and policy influence are optimized and a dissemination platform is established	4.1. Design and establishment of a internet platform including institutional set-up and financial mechanism. 4.2. Quarterly information updates incl. information exchange with CCAC and operation of the platform

Annex 2: Documents Used

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Annex 3: List of Interviews

ID	Institution / Persons	Date
1	**CCAC**; R. Thönen	16.6.2015
2	**SDC**; P. Sieber	17.6.2015
3	**Terraconsult**; R. Grossman	17.6.2015
4	**Air Consult**; G. Leutert	17.6.2015
5	**Universidad Nacional**; H. Acevedo	13.7.2015
6	**UMUS, Ministerio de Transporte;** Juan Camilo Florentino	13.7.2015
7	**SDA;** Ramon Villamizar; Nidia Gomez; Andrea Cortes; Isabel Molina; Hugo Saenz	14.7.2015
8	**TransMilenio, STT;** Laura Galeano, Deysi Rodriguez, Alejandro Gonzalez, Yezid Olade, Fernando Remolina, Joyce Gill, Adriana Pallz, Alvid Amparo	14.7.2015
9	**Operators TransMilenio:** representatives of TM SA, Express del Futuro, Consorcio Express, Siga, Metrobus, SI99, Este Es Mi Bus, SomosK, Transit SAS, Transmasivo, Ciudad Movil, ETIB SAS, Conexion Movil, EEMB, Masivo Capital, Gmovil (see list below)	14.7.2015
10	**SUBUS;** R. Tapia	16.7.2015
11	**Geasur**; A. Reinoso	16.7.2015
12	**MMA;** Nancy Manriquez	17.7.2015
13	**Swiss Embassy in Chile;** Frank Schürch	17.7.2015
14	**Sedema Mexico;** A. Mediavilla, C. Dominguez	29.7.2015
14	**SDC Peru;** R. Millan	30.7.2015

Participants Meeting with Operators TransMilenio:

ALCALDÍA MAYOR
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TRANSMILENIO S.A.

EMPRESA DE TRANSPORTE DEL TERCER MILENIO TRANSMILENIO S.A
LISTADO DE ASISTENCIA CAPACITACIÓN EXTERNA O REUNIÓN

NOMBRE CAPACITACIÓN Ó TEMA DE REUNIÓN	NOMBRE DEL FACILITADOR U ORGANIZADOR		
Experiencia proyecto filtro de particulas - concesionarios TM-SITP	TRANSMILENIO S.A.		
ÁREA, ENTIDAD CAPACITADORA U ENTIDAD ORGANIZADORA	FECHA		DURACIÓN
Consultor COSUDE (Dr. Jurg Grutter)	15	07 2015	2 horas

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Consultor COSUDE (Dr. Jurg. Grutter)	15	07 2015	2 horas

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