LIFE 08 ENV/F/000487

Inception Report
Covering the project activities from 01/01/2010 to 31/01/2012

Reporting Date
31/03/2012

LIFE+ PROJECT PHOTOPAQ

Demonstration of Photocatalytic Remediation Processes on Air Quality

Data Project

Project location	Lyon - France
Project start date:	01/01/2010
Project end date:	31/12/2013 **Extension date:**
Total budget	4 018 190 €
EC contribution:	1 984 573 €
(%) of eligible costs	49.88

Data Beneficiary

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1. Table of contents

List of abbreviations

CA	Consortium agreement
NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
HONO	Nitrous acid
HNO_3	Nitric acid
O_3	Ozone
VOC	Volatile Organic Compound
HCHO	Formaldehyde
PM10,	Particulate matter with particles measuring 10µm or less
PM2.5	Particulate matter with particles measuring 2.5µm or less
CO_2	Carbon dioxide
NO_y	Nitrogen oxides
THC	Total hydrocarbons
TiO_2	Titanium dioxide
NO_x	Nitrogen Oxides
MoT	Monitoring Team
PI	Principal Investigator

2. Executive summary

In this project, the aim is to demonstrate the usefulness of photocatalytic materials for air pollution reduction in the urban environment. Hereby, levels of air quality that do not give rise to significant negative impacts should be reached, a concept whose aim is to progress beyond the emission reductions and their technical limitations of the currently available standard techniques.

In the very recent years, photocatalytic self-cleaning and "de-polluting" materials have been suggested as a remediation technology mainly for NO_x and aromatic VOCs in the polluted urban environment. The associated technologies have been launched on the European market with the aim to have a positive impact on urban air quality and the corresponding effects of the health of the urban population. These commercial products are based on the photo-catalytic properties of a thin layer of TiO_2 deposited at the surface of the material (such as glass, pavement …) or embedded in paints or concrete. The use of TiO_2 photocatalysts as an emerging air pollution control technology has been reported in many European areas.

However, it seems that both the effectiveness and the real impact on air quality of these relatively new technologies up to now have been demonstrated only in a very limited manner in real scale applications before going into the European market.

Assessing and demonstrating the effectiveness of these depolluting techniques have a real EU added value both in terms of policy making (and implementing the EU air quality strategy) and economics (by providing a demonstration of the actual performance of a new technique).

3. General progress.

3.1 Summary of the general progress

The project's official starting date is January, 1st 2010. The project has been launched by the Kick of Meeting in Lyon on the 13 and 14th January 2010. This project aims at evaluating the feasibility of using TiO_2 based products to alleviate the air pollution under real atmospheric conditions. All stakeholders identified confirmed their respective involvement in the project. Most of the actions have started earlier than initially scheduled to match the currently active discussions.

On the 31st January 2012, the actions implemented by the consortium comprise:

Preparatory actions:

- Investigate the influence of photocatalytic surface films on atmospheric relevant reactions by flow tube experiments (species investigated NO, NO_2, HONO, HNO_3,VOC, tracers), identify the particulate tracers compounds for photocatalytic reactions in the gas phase under atmospheric conditions in the laboratory and in the field measurements (tracers studied are Inorganics A1 HNO_3 identified as a product of NO_2 uptake and organics tracers), identify the low volatile photocatalytic reaction products in the aqueous runoff of coated model surfaces (new runoff reactor constructed and measurements done), screening of photocactive materials used in the field site (CTG's old and new samples, Brussels tunnel samples analyzed).

-Provide the protocols and techniques for the evaluation of photocatalytic materials (pollutants investigated NO, NO_2, O_3, propene, pyrole, HONO), identify the impact of the selected materials on the loss of air pollutants (pollutants investigated NO, NO_2, O_3, propene, pyrole, HONO), identify and characterize the gas tracers and particles (*O_3, HONO, HCHO)*

-Provide a general protocol for the field studies by the definition of the field requirements for I1 and I2, by the definition of the parameters to be measured (Gaseous species : ozone, NO, NO_2, nitrous acid, major hydrocarbons and oxygenated volatile organic compounds , PM_{10}, $PM_{2.5}$, organic fraction aerosol, nitrate fraction of the fine aerosol, sulphate fraction of the fine aerosol and Light spectrum), by the definition of the spatial and temporal distribution of the measurement (2 weather stations have been implemented for I2 : wind speed and direction, temperature, relative humidity, rainfall), and by the definition of the parameters to be transferred to P4 actions.

-Define the instruments to be used in the measuring campaign, foresee the intercomparison and the intercalibration (NO, NO_2, HONO and CO_2 instruments have been successfully intercalibrated for the tunnel campaigns, still under evaluation: HCHO, carbonlys, particle number, particle mass, particle composition)

Implementation actions:
-As stated and agreed by the commission, the first campaign has been shifted toward the end of PhotoPAQ. Nevertheless, the site selection process is almost finalized; Bergamo (CTG site) shall be the next implementation site, "outdoor campaign".

-The second implementation action "indoor campaign" has been conducted in September 2011 in Brussels. The Leopold II tunnel in Brussels was taken as field site. The protocol to carry out the monitoring campaign has been implemented, the realization of the field trial has been done (application of photocatalytic materials, installation of the lighting system...) and the data collection during the pre and main campaign has been conducted.

- A preliminary assessment of the current state of the air quality and the geometry of the field site has been done in order to optimize the measuring campaign. First a review of the air quality of the greater area surrounding the tunnel field testing site was conducted, detailed drawings and blueprints from the Leopold II road tunnel were provided, detailed data for the direct road traffic emissions inside the road tunnel, schematics for the tunnel's ventilation system,...were put at disposal to assess the depolluting effectiveness and evaluate the numerical modelling results.

Dissemination actions:
-The web site has been implemented in April 2010 and monthly updates are done. Moreover, the PhotoPAQ consortium publishes a newsletter twice a year, subscriptions are done online.
-A press conference has been organized to launch the field campaign in Brussels on September the 8th, 2011 (the press releases are available on the website).
-PhotoPAQ participated to the JEP as sponsor in September 2011. A short documentary of the field campaign in Brussels has been produced and broadcast.
-200 brochures have been distributed and 5 posters has been realized and used for all events.

All these points are subject to a precise description in the technical part of this report.

3.2 Assessment as to whether the project objectives and work plan are still viable.

This project aims at evaluating the feasibility of using TiO_2 based products to alleviate the air pollution problem under real atmospheric conditions.
It advertised following mains objectives:

- developing the testing methodology for photocatalytic removal/production of NO_x, HONO, radicals, large number of VOCs and particles, with all tests being performed under atmospherically relevant conditions
- testing the photocatalytic activities of the commercially available TiO_2 based products in order to examine the pollutant removal effectiveness, (assessing if these depolluting surfaces are sinks or sources of pollutants)
- designing better environmental indicators and methods to assess the impact of this new technology in European cities,
- providing recommendation to the European authorities on the practical application for air treatment, (including a numerical "demonstration tool" for the depolluting action).

All these objectives are still viable. At the time of writing, no major failure risk has been identified. However there are some modifications in the initial work plan in order to complete efficiently the project's objectives:

Preparatory actions:

- The P1 actions should be prolonged as this will enable to (i) study the tracers and organics degradation and (ii) operate the newly designed runoff reactor. These laboratory results will be very valuable for the new Brussels tunnel campaign #2 foreseen for May 2012. The P1 actions already permitted to investigate species: NO, NO2, HONO, but some complementary research could be necessary to do: HNO3, VOC, tracers during the implementation actions (I1 & I2). Moreover, in order to identify the low volatile photocatalytic reaction products in the aqueous runoff of coated model surfaces, new measurements need to be done with the new runoff reactor constructed. The lab experiments are relevant to be maintained up to the end of the project but with no budget impact (54% of the planned budget for P1 action has been used up to the 31/01/12). The extension of the P1 action will enhance the results quality.

The actions P2, P3, P4 are relevant to be maintained up to the end of the project but with no budget impact (for these 3 actions, the initial budget has not been expensed). During the implementation action (I2), it has been shown that all the Preparatory actions are clearly deeply linked with the field actions. The possibility for the PhotoPAQ team to go back to the lab tests during the both implementation campaign is is essential to achieve satisfactory results even above the initial targets and to obtain relevant objectives. The extension of the period for the preparatory actions won't involved any delay in the implementation actions or all others actions of the project as the main labs actions to conduct the field campaign has been done. It is now more efficient to continue together preparatory and implementation if requested.

- The results obtained for the P2 actions in all facilities showed a decrease of NOx in the presence of the treated surfaces, which may indicate an effect of TiO_2 on the atmosphere containing this pollutant. The planned tests were all conducted; however, more tests are requested depending on the reformulation of the materials that might be used in the implementation actions and during the both campaigns I1 and I2. Therefore, P2 should be extended up to the 31st December 2013, with no extra cost and no objectives changes.

- The experience from the last months has shown that the work on the field strategy is linked with the field actions. Indeed adjustment of the field strategy has to be carried out until the very last days before the campaign to take advantages from local opportunities. Considering that the agenda for field actions has been extended, an extension of the P3 action until September 2013 is required, with no extra cost and no objectives changes.

- All instruments to be used in action I1 in Bergamo will be defined, a continuous quality check of the instruments used in P1, P2, I1, I2 will be done. The finalization of the intercomparison data from the first I2 tunnel campaign for HCHO, carbonlys, particle number, particle mass, particle composition will be made. The intercomparison for CO, VOCs and THC will be repeated in the next I2 tunnel campaign, in addition to the intercomparison of the other instruments. All instruments used in the I1 action in Bergamo will be intercompared again at the I1 field site. The results will be published on workshops (e.g. Corsica), and conferences and in international journals. Therefore, P4 should be extended to end of September 2013, with no extra cost and no objectives changes.

Implementation actions:

-The action I1 will involve the following actions to be achieved: acquire final authorization to use the identified site, finalize the measurement protocol, collect geometrical data, and optimize the application … The action is planned to ending the 30th December 2013. The global foreseen cost for the "outdoor campaign" is not completely finalize but we won't exceed the initial budget.

- A second measuring campaign will be carried in the tunnel of Brussels out in May or June 2012 in order to encounter the difficulties met during the first measuring campaign. In the second measuring campaign the test site will be enlarged and the light intensity increased. Following actions will be done: visit of the tunnel by CNRS-LISA on the 9th of February 2012 (technical room) and by BRRC on the 15th of February 2012 (tunnel) in order to determine the length of the second test site, define new specifications towards the lighting system (January-March 2012), do the preliminary tests (lab scale) to see whether the tunnel surface can be activated under the tunnel conditions with UV (BRRC, March 2012), define new specifications towards the contractor (March 2012), check the light intensity from the new lamps, apply the material, installation of the lighting system: April 2012, execute the measuring campaign: June 2012.

The extra cost for the second "indoor campaign" is estimated to 80Keuros. The cost of the both campaigns will be merged, and the implementation global budget will be respected. This extra cost will be integrated and will not have any consequences on the others actions.

In section 4.3 of the report, relevant parameters to achieve these objectives are measured which to evaluate progress in achieving each objective listed.

In the section 6, more details on the foreseen expenses are listed.

3.3 Problems encountered.

The actions planned in 2010 and 2011 are confirmed and were implemented. However some problems in the preparatory actions and implementation actions which do not alter the overall project have been met:

Preparatory actions:
P1: First samples (as coated glass plates) arrived in the laboratories 9 months after the project starting date (addressed as 'old samples'). As the PIs of P1 requested new material, this arrived in May 2011 (addressed as 'new samples'). Finally, after the Brussels tunnel campaign, samples prepared during the tunnel application as well as samples prepared with the raw material were tested in the laboratories of BUW and IfT. The results revealed that more experimental studies are needed to ensure the quality of the tests done and therefore, the action P1 should be prolonged. The solution for the delivery delay is to extend the period but with no extra cost.

P2: Due to the late delivery of the samples, a first series of tests was conducted on other materials in order to prepare the test protocols. In this series, the adherence between the provided material and the substrate was not durable, additional tests under vacuum had to be carried out in order to see if no contamination would arise from the substrate. More tests might be requested depending on the formulation of the materials to be used in the upcoming measuring campaigns (I1 and I2). The solution for the delivery delay is to extend the period but with no extra cost.

P4: The NO_2-LOPAP instrument planned to be used in I2 was not in operation in September 2011. Thus, only the two standard chemiluminescence instruments were used. However, data were corrected using the experience from the interference study (Villena et al., 2012). The correction is typically <5 % in the tunnel. The intercomparison for CO, VOCs and THC were not successful since one or both of the duplicate instruments failed. Intercomparison will be repeated in the next tunnel campaign.

Implementation actions:

I1: The main difficulty in looking for the requested site is to find a real urban place able to fulfil the main requirement especially regarding the applied surface and the covering of facades. Anticipating those difficulties, we put forward this task. Even if this solution was not successful (another site in Italy is under discussion) it allows us to change the strategy by changing the requirements.

I2: During the implementation of the "indoor campaign", some difficulties came up: Tunnel section was not painted entirely, but only about 70m of the planned 90m, no 'burn-free' period was foreseen for the photocatalytic material: due to the tight schedule of placement of the material and the lighting, the material could not be activated by the UV-light prior to the measuring campaign, mmisaligned orientation of lamps at the beginning of the main campaign: change of lamps placement, light intensity was lower than expected, defection of one CO_2-sensor, THC-sensors (both) and CO (one) failed. Thus, a second measuring campaign will be carried out in May or June 2012 in order to reply to the difficulties and problems met. The extra cost will be cover by the PhotoPAQ budget and his partners. The results on the "indoor campaign" will be available by mid 2013 (12 months delay). The delay on the dissemination on the results won't have any impact on the implementation on the "outdoor campaign", the preparatory phases for "indoor campaign" have been conducted and the know-how is present.

I3: One of the difficulties in the implementation of I3 was: gathering a complete set of data for the review of the air quality from urban background stations. The local hosts however, managed to gather the data required through their local contacts. The delay in the selection of the outdoor field trial site results in a delay in the submissions of deliverables vii and viii. However, as a solution it was suggested to submit initial versions for these deliverables containing information only on the Leopold II trial and submit the final versions upon completion of the outdoor experiment in Bergamo, Italy. A delay in the initial version of deliverable viii was also observed due to the fact that the 1st phase of the Leopold II trial was also delayed. As a result it was impossible to obtain detailed measurements for the traffic load and wind speed inside the tunnel. The data measured during the campaign were used as input boundary conditions for the 3rd set of numerical simulation that are currently under way and scheduled to finish by the end of April 2012, when the deliverable is expected to be submitted.

4. Administrative part

4.1. Description of project management

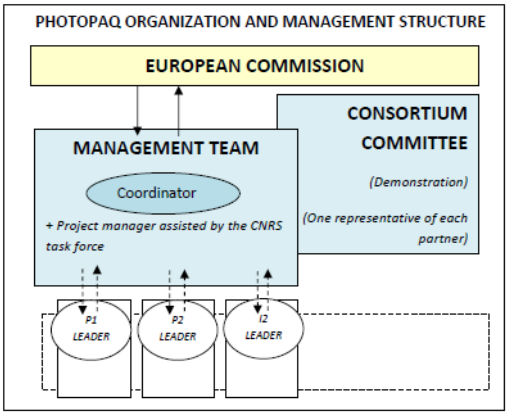
The coordination is lead by the partner 1a, the CNRS-IRCELYON. In the initial proposition, the management was organized around 3 main structures:

(i) a **Consortium Committee**, which is empowered to make high-level decisions on every aspect of the project together with the crucial duty of ensuring the integration of the various activities across PhotoPAQ.
(ii) the **Research Activity Leaders** in charge of the technical management.
(iii) **Management Team** dealing with the day-to-day management.

A consortium Agreement, signed the 27th September 2010 describes in details the organizational structure and the rights and duties of the operational bodies responsible for the decision-making. This agreement can be found in Appendix N°3

During the implementation of the PhotoPAQ project, we realized that it was more appropriate to merge the consortium committee meetings with the management team meetings. Indeed, the action leaders are also the representative partners for the consortium meeting and both meetings have been scheduled in the same period.

Thus the PhotoPAQ consortium has held a series of meetings since January 2010, with its various structures, guaranteeing the implementation of all actions at European level. The respective roles of the various structures involved in the project organization are summarized below:



a. **Consortium Committee**

The **Consortium Committee** is the decision-making body of the Consortium. It is composed of one representative from each partner organization, together with associated partners, and chaired by the Project Coordinator. Its role is to make high-level decisions concerning every aspect of the PhotoPaq network life: technical, financial, schedule, partnership, dissemination and exploitation.

The Consortium Committee met and will continue to meet on yearly basis, and specifically, annual review meetings and a final review meeting will be held. Extraordinary meetings could be called for, should the need arise.
Date of the meeting: KoM the 13th and 14th January 2010, the 31st January and 1st February 2011 in Brussels, and the 24th -26th January 2012.

Minutes of these meetings can be found in Appendix N°1.

b. **Management Team**

The technical and demonstration aspects of the project are the responsibility of the management team, chaired by the coordinator, who is finally sharing the overall scientific managerial responsibility of the project. The management team is the link between the consortium and the responsible scientific officer and administrative services at the EC and shall perform all tasks assigned. This management group (constituted by the coordinator and the action leaders) meet on six months basis in order to ensure an on-going flow of information and data between partners.

Date of the meeting : KoM the 13th and 14th January 2010, the first management meeting on the 15th and 16th July 2010, the second management meeting on the 31st January and 1st February 2011 in Brussels, the third management meeting on the 4th July 2011 and the 24th - 26th January 2012.

Minutes of these meetings can be found in Appendix N°1

c. **Research Activity Leaders**

The Action leaders coordinate the actions in all work-packages, inform the coordinator of the progress project status, results obtained and problems encountered, work scheduled, decision and questions and to implement decision.

The Actions Leaders are listed in the organisational chart below.

d. **Project Coordinator**

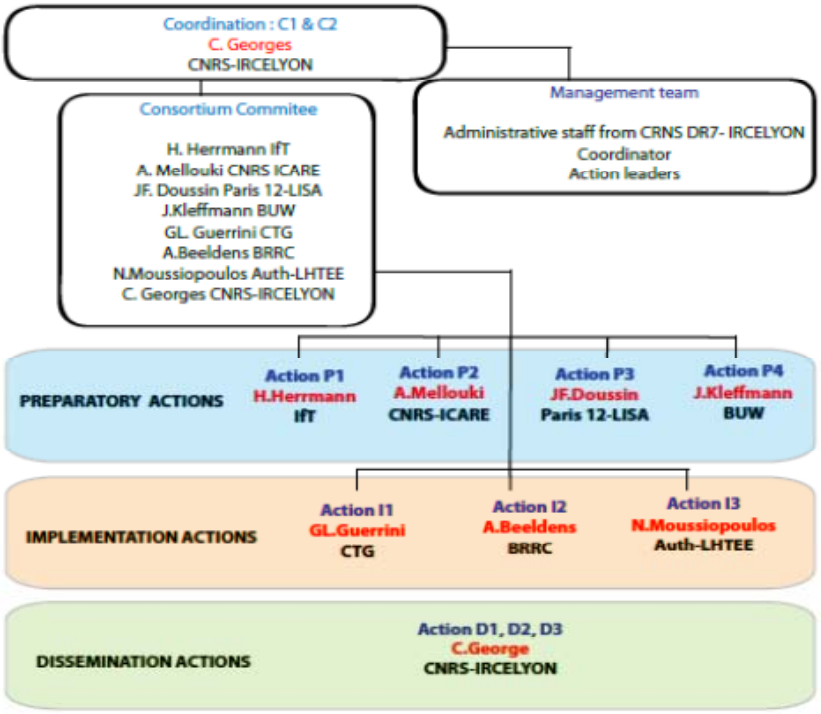
The project coordinator *Dr. Christian GEORGE* is managing the project. The coordinator's main tasks are the monitoring compliance by the parties with their obligations, the collecting, reviewing and submitting information on the progress of the project and the preparation of the after-Life+ dissemination plan, the preparation of the meetings, proposing decisions and preparing the agenda of General assembly meetings, chairing the meetings, preparing the minutes and monitoring the implementation of the decisions, the transmission of documents and information connected with the project and the administration of the community financial contributions.

The project coordinator is assisted by a project manager who is part-time dedicated to the management of the project and is responsible for monitoring the day to day and overall progress of the project. The Project manager, *Mrs Audrey PHILIPPE-SABOUL* has been hired the 1st February 2011 with part-time contract at 70% for the first four months and with a part-time contract at 50%. The Job description can be found in Appendix N°2.

The description of the management and coordination actions of the consortium, the project coordinator and the management team will be described in the technical part under the results of the action named C1 and C2.

4.2. Organization chart of the project

The coordination is lead by partner 1a i.e., the CNRS-IRCELYON. However each action is lead by the PIs listed below:



5. Technical part

5.1. Actions.

5.1.1. Action C1 – Successful implementation of the 10 actions by the 7 beneficiaries

Beneficiary responsible for implementation**:** CNRS-IRCELYON

Contributors: CNRS-IRCELYON

Main Objective: the successful implementation of the 10 actions by the 7 beneficiaries
Indicators: monitoring of the effectiveness of the actions

Expected results:

1 /-Effective and constant workflows & Dissemination of information within the project
Indicators: Number of meetings, implementation and monthly update of the monitoring tools
2 /-Regular submission, validation, storage and dissemination data (including delivrables).
Indicators: availability of the information anytime

In order to ensure the implementation of the 10 actions by the 7 beneficiaries, the role of the project coordinator Mr *GEORGE Christian* and the project management is:

- *The monitoring compliance by the parties with their obligations*: Following the signature of the consortium agreement in September 2010, all the parties respect their obligations. The consortium agreement is available in the appendix N°3.

- *The collecting, reviewing and submitting information on the progress of the project:* The management team has implemented in June 2011 several monitoring tools. This template has been elaborated in order to follow the action with regard to the objective defined in the initial

proposal. This template is available in the appendix N°4 or on the intranet (website). Furthermore, the action leaders report on their preparatory or implementation phases during each management team meetings.

- *The preparation of the meetings: the agenda of General assembly meetings, chairing the meetings, preparing the minutes and monitoring the implementation:* the coordinator organized all the meetings, defined the dates and locations. He also defined the agenda and spread the minutes, via the PhotoPAQ mailing list created and via the intranet website. During the management team meeting, a detailed description of the activities of the last six month per action is done. The minutes are available on the appendix N°1.

Date of the meeting : KoM the 13th and 14th January 2010, the first management meeting on the 15th and 16th July 2010, the second management meeting on the 31st January and 1st February 2011 in Brussels, the third management meeting on the 4th July 2011 and the 24th -26th January 2012.

Please find below the table of the PhotoPAQ meetings and the main decisions:

		Planed		Actual		Main decisions
		Where	Duration / days	Where	Duration / days	
Management	Kick-off meeting	Lyon	2	LYON	13/14 Jan 2010	Decisions on the creation of the photoPAQ website Interchange the schedule for the field campaign
	Management meeting 1	Leipzig	1	Brussels	15/16 July 2010	Elaboration Consortium agreement Definition of the tunnel campaign site (I2) Due to a delay of reception of the cement sample, the Preparatory action faced delays of 6 months
	Management meeting 2 & Annual meeting 1	Paris	1	Brussels	31 Jan -02 Feb 011	Distribution of PhotoPAQ brochures Definition of the first PhotoPAQ workshop (JEP: Bordeaux) Date of the tunnel campaign has been validated
	Management meeting 3	Wuppertal	1	Brussels	04 July 2011	Decision of the organization of the PhotoPAQ workshop in Corsica in 2012 Decision to do a film on the tunnel campaign Decision of the date of the press conference Organization of the tunnel campaign and decision of the deadlines
	Management meeting 4 & Annual meeting 2	Orléans	1	Thessaloniki	24-26 Jan 2012	Decision to proceed to 2nd campaign in Brussels Decision for the outdoor site
	Astrale meeting			Lyon	20 April 2010	
	Launched Life + programme Day			Paris	04 March 2010	
	Life + day (Christian George)			Paris	10 May 2010	
	Astrale Meeting			Lyon	21 Feb 2011	
	Astrale Meeting			Brussels	21 Sept 2011	

Preparatory phase	P1 - done during annual meeting					
	Coordinator visit (Christian George)			Paris	01 June 2010	
	Visit			Leipzig	15/16 April 2010	
	Visit Hartmut Herrmann + Christian ICARE			Orléans	Sept 2011	
Implementation	I2 - Field campaign	Brussels	15	Brussels	7-23 Sept 2011	
Dissemination	D3 – PhotoPaq conferences 1, 2 and 3	Not decided yet	Not decided yet	Bordeaux JEP	29-30 Sept 2011	

- *The transmission of documents and information connected with the project*: internal and external communication about the project, regular meetings have been implemented, and various electronic tools (emails, teleconference,) have been used to exchange information with the consortium beneficiaries.

Date of the meeting : KoM the 13th and 14th January 2010, the first management meeting on the 15th and 16th July 2010, the second management meeting on the 31st January and 1st February 2011 in Brussels, Call conference organized in April 2011, the third management meeting on the 4th July 2011 and the 24th -26th January 2012.

DELIVERABLE PRODUCTS OF THE PROJECT

	Name of the Deliverable	Code of the associated action	Deadline
(i)	Investigations on the influence of photo-catalytic surface films on atmospheric relevant reactions by flow-tube experiments	action P1	30/06/2011
(ii)	Identification of gas phase and particulate "tracer" compounds for photo-catalytic heterogeneous reactions to be searched for in the field measurements	action P1	30/06/2011
(iii)	Identification of low volatile photo-catalytic reaction products in the aqueous runoff of coated model surfaces by bench-top reactor experiments identify "tracers" to be searched for in the field	action P1	30/06/2011
(iv)	protocols and techniques for evaluation of the use and efficiency of photo-catalytic depolluting materials on air quality	action P2	31/12/2011
(v)	basis for authorities to adopt a more integrated approach to urban management by informing stakeholders to use the techniques and methods successfully tested in the project.	action P2	31/12/2011
(vi)	scientific strategy of the field experiments	action P3	29/02/2012
(vii)	Review of air quality measurements and studies for the selected regions of the field sites	action I3	30/06/2010
(viii)	Numerical modelling results for the optimisation of the field sites and the expected achievable de-pollution	action I3	30/06/13 (final)
(ix)	Field measurements data analysis and geographic classification	action I3	30/06/2013
(x)	Evaluation and validation of the numerical modelling technique	action I3	30/06/2013
(xi)	Integrated assessment and cost benefit analysis	action I3	30/06/2013
(xii)	Prepare annual reports including: - a recommendation report about the approach in order to apply in an urban environment the photocatalytic materials; - a report concerning the monitoring methodology to be adopted in relevant project (e.g. an "intelligent management of a tunnel" by using specific sensors for pollutants); - a "demonstration tool" for the depolluting action, which can be obtained from the numerical modelling actions.	action D2	On going
(xvii)	International dissemination of results based on a number of modules: - Brochure published, - Press releases published, - - Workshops implementation - Reviewed publications.	action D3	On going 31/12/2012 31/12/2012 31/12/2011 31/12/2012 31/12/2013 31/12/2013 31/12/2013
(xvii)	After-LIFE Communication Plan	action D3	31/03/2014

The main communication and dissemination activities connected to the project have been implemented mainly during the tunnel campaign (I2). We organized a press conference on September 8th, at 10:00pm within the tunnel. The press conference started by an introductory talk of the Ministry of Transport and Mobility of the Brussels Region, by a presentation of PhotoPAQ by its coordinator, and ended by a visit of the demonstration site within the tunnel. The announcement of the press conference (English, French and Dutch) is available in appendix N°5. The press release is available in Appendix N°6 and on the website (http://photopaq.ircelyon.univ-lyon1.fr/Press-review)

In the meanwhile, the PhotoPAQ team decided to hire a company in order to elaborate a short documentary based on the PhotoPAQ demonstration site in Brussels, as the power of images is an efficient way of dissemination. This video is available on the PhotoPAQ website (http://photopaq.ircelyon.univ-lyon1.fr/PhotoPAQ-campaigns/Indoor-campaign).This documentary has been largely broadcast by all the partners. It has been also widely used for the first PhotoPAQ workshop in Bordeaux (the details of the cost and the diffusion impact will be detailed in the action D3).

During the field campaign, a notice board presenting the PhotoPAQ project has been set-up at the entry of the tunnel. A picture of the notice board is available in appendix n°7 and on the website (http://photopaq.ircelyon.univ-lyon1.fr/Images). The PhotoPAQ management team decided also to make PhotoPAQ T-shirts; pictures are available in appendix N°7 and on the website

As soon as the result of the field site campaign in Brussels are ready for dissemination, we will post them and share this information via the website (http://photopaq.ircelyon.univ-lyon1.fr/PhotoPAQ-campaigns/Indoor-campaign). The corresponding section on the website has already been created.

- *The administration of the community financial contribution*: regarding the consortium agreement, the beneficiaries shall send on a six month basis the financial statement and the supporting documents for the last six months of activities. The coordinating beneficiary has collected and retained copies of all supporting documents of all associated beneficiaries.

Moreover, this action is evaluated by constant and efficient flows of information. The regular communication between the action leaders, the consortium and the management team is essential.

- A PhotoPAQ mailing list has been created and used for all communications (photopaq-partners@ircelyon.univ-lyon1.fr), with 40 e-mail addresses.
- In order to guarantee constant workflows, an intranet web site has been developed within the PhotoPAQ website (http://photopaq.ircelyon.univ-lyon1.fr/). A guideline for use has been made and sent to the partners in May 2011. This guideline is available in appendix N°8 (with the login). This intranet is very useful to share working documents, maps, agendas and minutes of the meeting, the preliminary results and financial documents, all partners of the consortium have editorial access and can share documents.

Steps of the implementation of the action:

-1st April 2010 and June 2011: Implementation of the website & Creation of the mailing list/Implementation of the intranet website and elaboration of the guideline
- June 2011: Implementation of the guideline for the financial statement on six month basis
- February 2011, September 2011 and February 2012:Collecting the financial statement on a six month basis and consolidation of the consortium's financial data.

- February 2011 and September 2011: Preparation and organization of Astrale's monitoring and evaluation visit. Preparation of all the meeting (agenda, date, location, minutes and monitoring of the decisions).
- April-September 2011: Organization and coordination of the Brussels campaign
- September 2011: Preparation of the press conference
- April-September 2011: Preparation of the short documentary (draft scenario, quotation, screen…)

GANTT Diagramm :

		Results																							
Indicators or precise activities list	Year	1st Year						2nd Year						3rd Year						4th year					
	Trimester	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Effective and constants work flows & Dissemination of information within the project:																									
Implementation on the PhotoPaq intranet and regular updated (minutes meeting, action plan) / number of document available on intranet	Planed																								
	Actual																								
Number of coordination meeting (6) / Management meeting	Planed																								
	Actual	1			1			2			1			1											
Regular submission, validation, storage and dissemination data																									
Storage data following the Brussels campaign and for the outdoor campaign	Planed																								
	Actual																								

Steps of implementation for the next period:

- Management meeting every six months. The next meeting will be held in July 2012 in Bergamo

Please find below the planning of the next PhotoPAQ meeting:

		Planed		ACTUAL	
Management	Management meeting 5	Bergamo	1		
	Management meeting 6	Paris	1		
	Management meeting 7	Lyon	1		
	Management meeting 8	Thessaloniki	1		
	Annual meeting 3	Thessaloniki	2		
Preparatory phase	P1 - done during annual meeting				
	P2 - done during annual meeting				
	P3	Paris	2		
	P4	Wuppertal	5		
Implementation	I1 – Field campaign	Italy or France	15		
	I2 – Second Field campaign	Belgium	15		
Dissemination	D1 – done during management meeting				
	D2 - done during management meeting				
	D3 – PhotoPaq conferences 1, 2 and 3	Not decided yet	Not decided yet	Corsica	14-17 May 2012

- Regular update of the website and the intranet website.
- Organization and coordination of the Outdoor campaign
- Organization and coordination of the PhotoPAQ colloqium in Corsica the 14-17 May 2012
- Storage of the Field data for the Outdoor campaign
- September 2012 and August 2013: Collecting the financial statement on six months basis and consolidation of the consortium's financial data.
- January 2014: collection of the financial statement for the final financial report.

5.1.2. Action C2 – Monitoring the effectiveness of the actions

Beneficiary responsible for implementation: CNRS-IRCELYON

Contributors: CNRS-IRCELYON

Main Objective: Monitoring the effectiveness of the actions: possibility to verify the progress and status of the project any time

Expected results:
1/ -The financial, technical report sent on a six months basis
Indicators: Milestones, Number of reports collected

In September 2010, the consortium agreement (CA) has been signed by all partners; the CA defines all the obligations and duties of the beneficiaries. The consortium agreement is available in appendix N°3.

The management team proceeds to a permanent comparison between the actual progress of the actions and the project plan and signal either verification or a deviation from the plan. Thus the management team, chaired by the coordinator, elaborates monitoring and evaluation tools, in order to compare at anytime the progress of the action. This template is available in appendix N°4 or on the intranet website. The reports are sent on a six months basis.

The main indicators for the C2 actions, described in the initial project, are the Milestones. The Milestones table allows us to follow the progress of the project's actions. However due to the delay of the delivery of the sample, due to the interchange of the implementation actions, the milestones table needs to be updated.

Name of the Milestone	Code of the associated action	Deadline	Actual Deadline
Laboratory testing of photocatalytical material	Action P1	30/12/2011	31/12/2013
Built a depolluting site, by applying photocatalytic cement-based materials	actions I1 + I2	30/06/2011	30/09/2013
Collected data based on the defined monitoring campaign methodology	actions I1 + I2	30/06/2012	30/09/2013
Collected data based on the defined monitoring campaign protocol	actions I1 + I2	31/12/2012	30/09/2013
Tests under controlled atmospheric conditions	Action P2	31/12/2011	31/12/2013
Field studies scientific strategy and implementation	Action P3	31/12/2011	30/09/2013
Instrumentation Quality Insurance	Action P4	30/06/2013	30/09/2013
In situ monitoring campaign – 1	Action I1	31/12/2012	31/12/2013
In situ monitoring campaign – 2	Action I2	31/12/2012	30/06/2012
Field site optimization and design	Action I3	30/04/2011	31/12/2013
Integrated assessment and cost benefit analysis	Action I3	30/06/2013	31/12/2013
Geographic classification of expected de-pollution performance	Action I3	31/12/2012	31/12/2013
Operational website	Action D1	30/06/2010	31/09/2010
Reporting	Action D2	31/09/2010 31/03/2013 31/03/2014	Done 31/03/2012
International dissemination of results	Action D3	31/12/2013	31/12/2013
Website communication	action D1	On going	31/12/2013

Laboratory testing of photocatalytical material:

The project is currently facing some delays due to the 9/14 months delayed delivery of the samples for the preparatory phases and more recently by the fact that the samples effectively produced for industrial purposes are different from those prepared for laboratory testing. Therefore, this action requests a period extension in order to continue the testing on the samples effectively deployed in the tunnel and during the outdoor campaign. The preparatory phase should therefore continue and shall now end on 31/12/2013 instead of 31/12/11. Indeed, some complementary tests are required. However there won't be any extra cost for this action. The P1 deliverables are anyway available in appendix N°9.1.

Built a depolluting site, by applying photocatalytic cement-based materials

The first implementation site has been planned in 2011 and has been conducted in September 2011. The second campaign (outdoor campaign) has been delayed in order to define the most relevant site and is planned for the first semester 2013. That is why we request an extension of this action up to September 2013.

Collected data based on the defined monitoring campaign methodology and protocol

These actions must be done with the same schedule as the implementation actions and are therefore requiring an extension to collect and organize the data.

Instrumentation Quality Insurance

This action must be done with the same schedule as the implementation actions.

In situ monitoring campaign – 1 & In situ monitoring campaign – 2

During the kick-off-meeting, the consortium concluded that compared to Action I1 (outdoor campaign), action I2 (tunnel campaign) was more straight forward to implement mainly due to delays in selecting an appropriate site for the outdoor campaign. To counter balance these observations and facts, it was decided that in the initial work programme action I2 should replace action I1 and vice versa. As a result, Action I1 is now scheduled to take place in 2013.

The action I2 has been implemented in September 2011; however a second monitoring campaign will be performed during the first semester of 2012, see action I2 about he encountered problems. The action I1 will be conducted the beginning of 2013, for this reason we request an extension of the I1 implementation phase.

Field site optimization and design & Geographic classification of expected de-pollution performance / integrated assessment and cost benefit analysis/ International dissemination of results

During the implementation of the project, the management team realized that in order to conduct in satisfactory manner the field campaigns, the I3 action needs to be continuous during all the duration of the project, as a technical support to the field campaign. However there won't be any extra cost for this action.

Operational website & Website communication

The website has been on line since September 2010 and has been updated and used up to now.

Reporting

The inception report of the PhotoPAQ project has been sent on September 2010. The date of the next report planned for the 31/03/2013 will be changed. Indeed, we will replace this report by the mid-term report (31/03/2012).

GANTT Diagramm :

		Results																							
Indicators or precise activities list	Year	1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Possiblity to verify the progress and status of the project at any time																									
Number of meeting of the Management team, consortium committee	Planed																								
	Actual																								
Regular financial reporting	Planed																								
	Actual																								
Regular reporting technical	Planed																								
	Actual																								

Steps of implementation for the next period
-Monitoring tools will be sent on a six month basis
-Management team meetings and consortium meetings will be held to verify the milestones tables and the progress of each action

5.1.3. Action P1 - Laboratory testing of photocatalytical material

Beneficiary responsible for implementation: IfT - Prof. H. Herrmann

Contributors: CNRS-IRCELYON; IfT Leipzig; BUW Wuppertal

Main Objective**:** provide a complete chemical characterization of the gas phase products and the runoff samples as well as an identification of new chemical reactions on urban surface films.

Expected results:
1/ -Investigate of the influence of photocatalytic surface films on atmospheric relevant reactions by flow tube experiments

Indicator: Number of species investigated: NO: Done / NO_2: Done / HONO: Done / HNO_3: Open /VOC: Open / Tracer: Open.
Problems encountered: Late delivery of samples (9+5 month delay), partly insufficient quality of supplied samples.

2 / - Identification of gas phase and particulate "tracers" compounds for photocatalytic heterogeneous reactions to be searched for in experiments under atmospheric controlled conditions (P2) and in the field measurements (I1 and I2)
Indicator(s): Number of tracers studied: (A) Inorganic (A1) HNO_3 identified as a product of NO_2 uptake (BUW) *and (B) Organic* Tracers: Open

Problems encountered: Late delivery of samples, partly insufficient quality of supplied samples.

- Identification of low volatile photocatalytic reaction products in the aqueous runoff of coated model surface by bench top reactor experiments
Indicator(s): A) New runoff reactor construction and assembly Done, (B) Measurements with new runoff reactor, Open

Problems encountered: Late delivery of samples, partly insufficient quality of supplied samples.

3/ -Screening about photoactive materials to be used in the experiments under atmospheric controlled conditions (P2) and in the field (I1 & I2)

Indicator(s): Number of materials investigated to be deployed in the field experiments:

(A) CTG 'old' sample, Done
(B) CTG 'new sample, Done
(C) CTG Brussels tunnel product, Done
(D) STO Photocatalytic paints, Done (BUW)

The activity can be regarded finished despite the problems below. However, some further testing would be desirable to assist the planned second Brussels tunnel campaign.

Problems encountered: Late delivery of samples, partly insufficient quality of supplied samples.

Description of the action done 01/01/2010 – 31/01/2012

The proposed laboratory measurements in Action P1 are important for both the preparation and duration of the planned field measurement campaigns as well as to provide input data for the planned model calculations in the PhotoPaq project.

Partners involved in Action P1 are the CNRS-IRCELYON, the BUW at Wuppertal as well as the IfT at Leipzig (coordinating) to characterize the effectiveness and the influence on atmospheric processes of photocatalytic material used in the field campaigns under controlled conditions on the laboratory scale.

Due to problems described before, the Action P1 was delayed (cf. last reports). First samples (as coated glass plates) arrived in the laboratories 9 months after the project's starting date (addressed as 'old samples'). As the PIs of P1 requested new material, this arrived in May 2011 (addressed as 'new samples'). Finally, after the Brussels tunnel campaign both the laboratories BUW and IfT took the original material used in the joint tunnel campaign and produced by Italcementi and also studied this in the laboratories. During the experiments photocatalytic decomposition of different reactive nitrogen species (NO_x, NO_y) and volatile organic hydrocarbons was studied on the photocatalytic materials. The results indicate oxidation of the pollutants. Mechanistic and kinetic description of the reactions allows estimation of potential atmospheric impact.

Also, within P1 the photocatalytic material used in the Brussels tunnel experiments was applied in chamber studies in the Leipzig Chamber LEAK.

Steps of the implementation of the action P1

General

- First samples from CTG arrived 9 month after the project started (Def.: old samples)
- No new raw material was delivered by CTG before the tunnel campaign in Brussels → the new raw material was taken along from the tunnel in Brussels after the campaign, caused by the recommended one month preparation time of the samples on sand blasted glass substrate, the main experiments started only in November 2011 (Def.: new samples) (IfT)
- LEAK experiments started in January 2012 → ongoing work (IfT)

(a) NO_2-Experiments:

- Strong dark reaction observed (γ_{dark} ca. 10^{-5}), which deactivates for high NO_2 dose. Behaviour observed for all samples. Much smaller dark reaction for photocatalytic paints (BUW and IfT).
- Additional photocatalytic reaction depending on the prior dark NO_2 passivation. Small photocatalytic reaction for fresh samples, increase with irradiation time ($\gamma = 0.5\text{-}2\times10^{-5}$ for noon-time irradiance level, 30 W m^{-2}). Effect was strongest for the tunnel samples. (BUW)

- Non-linear irradiance dependence of the reaction, which levels off at high irradiance level and became almost linear below 8 W m^{-2}. In contrast, a linear irradiance dependency is observed for the paints up to 30 W m^{-2}. (BUW, work in progress at IfT)
- The total uptake of NO_2 ($\gamma_{total} = \gamma_{photo} + \gamma_{dark}$) of the old samples ($1.9\times10^{-5}$ for 8 W m^{-2} irradiance) were slightly lower than for the new samples (2.3×10^{-5}). Unexpectedly, the tunnel samples showed the lowest reactivity (1.6×10^{-5}), although the material was specified to be similar to the new samples by Italcementi, which may be explained by the one day passivation of the sample surface in the tunnel (BUW).
- Non-linear NO_2 concentration behaviour is observed with a reaction order <1 already at <100 ppb, which can be explained by the Langmuir-Hinshelwood mechanism and a surface saturation of active sites by adsorbed NO_2. In contrast, for the paints, 1. order kinetics up to 800 ppb NO_2 level was determined (BUW).
- Product study: Nitrate (NO_3^-) is the major product with a yield of 72 %. In addition, significant nitrite (NO_2^-) yield of 22 % was observed, which is in contrast to the photocatalytic paints, which show negligible nitrite yields. This result indicates that HONO is mainly adsorbing on the concrete, but is not photocatalytically decomposed, which is confirmed by experiments with pure HONO mixtures (see below). In contrast, the paints show strong photocatalytic decomposition of pure HONO (BUW).
- There was no significant difference between the total uptake of NO_2 ($\gamma_{total} = \gamma_{photo} + \gamma_{dark}$) of the old samples ($5.2\times10^{-5}$ for 50% relative humidity) and the new samples (4.3×10^{-5} for 50% relative humidity) (IfT).
- Although the uptake coefficients are a little bit higher than from BUW, the values are in good agreement due to the higher irradiance level (approx. 60W m^{-2}) in the IfT set-up (IfT)
- Both old and new material showed a dependency of the total uptake of NO_2 on the relative humidity. The higher the relative humidity the higher is γ_{total} (from approx. 4.6×10^{-5} for 10% relative humidity to approx. 7.0×10^{-5} for 70% relative humidity) (IfT). This result is in contrast to the photocatalytic paints (BUW), which show decreasing reactivity with increasing humidity (>10 % r.h.). This difference can be explained by the humidity dependence of the strong dark reaction NO_2+H_2O of only the concrete samples. In contrast, the photocatalytic reactivity is expected to decrease with increasing humidity, caused by the blocking of active sites of the TiO_2 by adsorbed water.

(b) NO-Experiments:

- Very small dark uptake of NO observed ($\gamma_{dark} \sim10^{-6}$) in good agreement with the paints (BUW).
- High photocatalytic uptake of NO is observed ($\gamma = 1.5\times10^{-5}$ at 8 W m^{-2} irradiance), which is higher than the photocatalytic uptake of NO_2 under similar conditions. In contrast, the total uptake ($\gamma_{total} = \gamma_{photo} + \gamma_{dark}$) of NO and NO_2 were approximately similar ($1.5\text{-}2\times10^{-5}$ at 8 W m^{-2}). For photocatalytic paints similar results were observed (BUW).
- 1st order kinetics of NO is observed, for which the decomposition rate is proportional to the concentration up to 200 ppb, which is also in agreement with results from photocatalytic paints (BUW).

c) HONO-Experiments (BUW):

- Strong dark uptake of HONO is observed ($\gamma_{dark} \sim10^{-5}$), in line with the alkaline surface properties of the concrete, for which adsorbed HONO forms nitrite (NO_2^-).
- No photocatalytic uptake of HONO is observed ($\gamma_{photo} <10^{-6}$), in contrast to paints which show very strong uptake of HONO ($\gamma_{photo} >>10^{-5}$).
- The low photocatalytic reactivity of HONO is in good agreement with the significant NO_2^- yields in the NO_2 experiments (see above), in which $HONO/NO_2^-$ is formed as one product.

(d) Tracer / Organic experiments

Work on this is in progress both at BUW and IfT. Candidates for the reactive/non-reactive traces (non-harmful fluorinated trace gases) have already been identified. Optimization of the simultaneous quantification of both compounds by a sensitive mobile GC/ECD system is in progress.

(e) Runoff experiments

The new runoff reactor was built in the IfT workshops after its design. It is now available for measurements. Both the design and the realisation took more time than initially planned. Measurement work is in progress.

(f) LEAK chamber experiments in P1

A design was developed to implement glass-coated plates into the Leipzig Aerosol Chamber (LEAK). Systematic measurements are now in progress with the original CTG Brussels tunnel material. It will characterise effects on NO_x and organics, e.g. Toluene

- Small but measurable dark uptake of NO, which increases if lights are on (irradiance ca. 10 W m^{-2}).
- Dark uptake of NO_2 is higher than that of NO.
- Very fast uptake of O_3 which is independent on light. This result is in contrast to photocatalytic paints (BUW), which also show a light dependent uptake with γ_{total} of ca. 10^{-4}.
- During the photocatalytic uptake of NO as well as mixtures of NO with NO_2 a pronounced formation of O_3 can be observed. It needs to be clarified if this is due to NO_2 photolysis (i.e. chemistry to be described by the Leighton relationship) or a real surface process such as the one suggested to oxidize surface nitrate to surface NO_3 with its photolysis leading to oxygen atom, and, finally, gas phase ozon.
- For toluene no significant photocatalytic conversion or uptake could be measured. This result is also in contrast to photocatalytic paints (BUW), which show a γ_{photo} of ca. 10^{-5}.

GANTT Diagramm : Starting date 01/01/2011 - Ending date 31/12/2013:

Indicators or precise activities list	Year	Results																							
		1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Investigate on the influence of Photocatalytic surface films on atmospheric relevant reactions by flow tube experiments																									
NO2 studies	Planed																								
	Actual																								
NO studies	Planed																								
	Actual																								
NOy studies	Planed																								
	Actual																								
Identification of gas phase and particulate "tracers" compounds for photocatalytic heterogenous reactions to be searched for in experiments under atmospheric controlled conditions (P2) and in the field measurments (I1 and I2)																									
Inorganics Tracers	Planed																								
	Actual																								
Organics tracers	Planed																								
	Actual																								
Identification of low volatile photocatalytic reaction products in the aqueous runoff of coated model surface by bench top reactor experiments																									
Runoff Studies	Planed																								
	Actual																								
Screening about photoactive materials to be used in the experiments under atmospheric controlled conditions (P2) and in the field (I1 & I2)																									
Screening	Planed																								
	Actual																								

Deliverables (i), (ii), (iii): 2 deliverables have been done: The deliverables are available in appendix N°9.1.

Name: (i), (ii), (iii) Investigate on the influence of Photocatalytic surface films on atmospheric relevant reactions by flow tube experiments.
Short summary: Work in Wuppertal, Lyon and Leipzig led to a large data set on the different materials.

Name: Screening about photoactive materials to be used in the experiments under atmospheric controlled conditions (P2) and in the field (I1 & I2).
Short summary: Work in Wuppertal, Lyon and Leipzig led to a large data set on the different materials. The choice of the materials was, however, prescribed from technical demands and led bei CTG. The material applied in the Brussels tunnel is now well characterized.

Difficulties met and solutions presented.

Due to the problems described before, the Action P1 was delayed. First samples (as coated glass plates) arrived in the laboratories 9 months after the project start (addressed as 'old samples'). As the PIs of P1 requested new material, this arrived in May 2011 (addressed as 'new samples'). Finally, after the Brussels tunnel campaign both the laboratories BUW and IfT took the original material used in the joint tunnel campaign and produced by Italcementi and also studied this in the laboratories.

Two goals of P1 have now been fulfilled successfully, due to the delays in getting the material to the laboratories; however, the following two items need more experimental studies:

- Identification of gas phase and particulate "tracers" compounds for photocatalytic heterogeneous reactions to be searched for in experiments under atmospheric controlled conditions (P2) and in the field measurements (I1 and I2).
- Identification of low volatile photocatalytic reaction products in the aqueous runoff of coated model surface by bench top reactor experiments.

The P1 actions should be prolonged as this will enable to (i) study the tracers and organics degradation and (ii) operate the newly designed runoff reactor. There were substantial delays in the development of the new runoff reactor. The organic system studies still need to be performed at BUW and IfT.

Description of the actions for the next period 01/01/2012- 31/12/2013

As stated above, the labs involved in P1 are heavily working on the samples available now but need another six months to fulfil the missing two items.
Lyon: P1 finished his laboratory studies on the effects of the different photocatalytical materials on NO and NO_2.
BUW: Tracer and Organics studies foreseen, the studies will focus on HCHO and HNO_3.
IfT: Tracer/Organics and runoff studies foreseen. Investigations of model compounds (Aldehydes such as HCHO, Glyoxal, Toluene) in the benchtop reactor and the runoff reactor are foreseen. Variation of irradiance is planned throughout. A second LEAK campaign is also planned.

We suggest extending the period of P1 activities to do the above organics /tracer and runoff studies. These laboratory results will be very valuable for the new Brussels tunnel campaign #2 foreseen for May 2012. Due to delays in material supply, hiring students and scientists on time and delays in runoff reactor design and realization, the lab experiments should be continued up to the end of the project at no budget impact.

5.1.2. Action P2: Tests under controlled atmospheric conditions

Beneficiary responsible for implementation: CNRS- ICARE – Dr. W. Mellouki

Contributors: BUW, Paris12-LISA

Main Objective**:** Provide the protocols and techniques for real evaluation of the use and efficiency of selected photo-catalytic de-polluting materials under realistic and controlled conditions through a series of tests conducted in different laboratories and equipments

Expected results:

1 /-Protocol from pilot tests in the selected chambers and materials / provide the protocols and techniques for evaluation of the use and efficiency of photocatalytic de-polluting materials on air quality
Indicator(s): Number of tests performed (25), Number of samples tested (5) at, Number of pollutants investigated: NO, NO_2, O_3, propene, pyrrole, HONO (6 in total)

2 /- Impact of the selected materials on the loss of air pollutants under atmospheric conditions
Indicator(s): Number of tests performed (25), Number of samples tested (5), Number of pollutants investigated: NO, NO2, O3, propene, pyrrole, HONO (6 in total)

3/ - Identification and characterization of gas phase tracers and particles that could be formed.
Indicator(s): Number of tests performed: 10, Number of samples tested : 5, Number of pollutants investigated: O3, HONO, HCHO (3 in total).

Description of the action done 01/01/2010 – 31/01/2012:

Tests on different surfaces provided by CTG have been made using different facilities to check the behaviour of a number of pollutants on these surfaces. In addition, other types of materials, such as photocatalytic glass, were also investigated, since the provisions of samples from CTG were delayed.

As the adherence between the material provided and the glass substrate was not perfect, it was necessary to test the behaviour of these samples under vacuum prior to any use inside chamber which use vacuum session for cleaning (e.g. CESAM Chamber).
Four different chambers were used by partners 1b (ICARE) and 7(LISA)
(i) 2 Indoor chambers made of Teflon having different volumes (250 L and 7300 L) irradiated by artificial light
(ii) 1 indoor chamber (4200 l) made of stainless steel also irradiated by artificial light
(iii) one outdoor chamber irradiated by sunlight. These facilities are equipped with modern and highly sensitive analytical equipment (http://www.era-orleans.org/ERA-TOOLS/ and http://www.lisa.univ-paris12.fr/CESAM/Cesam_web-intro-eng.htm).

The tests were conducted on NO, NO_2, O_3, propene/NO_x and pyrole (this later being used as gas tracer candidate). In addition to the samples provided by CTG, a number of tests were conducted on samples taken directly from the Tunnel in Brussels (see I2 action).

In each facility, in order to determine the effectiveness of the tested materials, several runs were performed in the presence of non-treated surfaces and with TiO_2 treated surfaces inside the chamber. Low concentrations of the studied pollutants have been introduced in the chambers in the presence and absence of the sample plates and the gas phase composition was continuously analysed.

The results obtained in all facilities showed a decrease of NO_x in the presence of the treated surfaces, which may indicate an effect of TiO_2 on the atmosphere containing this pollutant.

The planned tests were all conducted; however, more tests might be requested depending on the reformulation of the materials that might be used in actions I1 and I2.

The main tests were performed; however, room is left for other possible tests related to the new field tests within actions I1 and I2.

Steps of the implementation of this action:
Test of the behaviour of the provided material under vacuum
Tests in small chambers
Tests in larger chambers

Gantt diagram : Starting date 01/01/2011 –Ending date 31/12/2013

		Results																							
Indicators or precise activities list	Year	1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Protocols from pilot tests in the selected chambers and materials / Provide the protocols and techniques for evaluation of the use and effiency of photocatalytic depolluting materials on air quality																									
Number of tests performed																									
Number of samples tested (5)	Planed																								
Number of pollutants investigated: NO, NO2, O3, propene, pyrrole, HONO (6 in total)	Actual																								
Impact of the selected materials on the loss of air polluants under atmospherics conditions																									
Number of tests performed																									
Number of samples tested (5))	Planed																								
Number of pollutants investigated: NO, NO2, O3, propene, pyrrole, HONO (6 in total)	Actual																								
Identification and characterization of gas phase tracers and particles that could be formed																									
Number of tests performed																									
Number of samples tested	Planed																								
Number of pollutants investigated: O3, HONO, HCHO (3 in total)	Actual																								

Deliverables (iv), (v): (deadline December 2011): The deliverables are available in appendix N°9.2 / 9.3.

Difficulties met and solutions brought**:**
The delivery of the sampled was delayed which led us to conduct a series of tests using other materials in order to prepare the test protocols.
The adherence between the material and the substrate was not sustainable which have led to the necessity of carrying out additional test experiment to verifying that no durable contamination could arise from its use in simulation chambers.

Description of the actions for the next period 31/01/12- 31/12/2013
-More tests if required with the new formulation of the materials

5.1.4. Action P3: Field studies scientific strategy and implementation

Beneficiary responsible for implementation: Paris12- LISA – Prof. Jean-François DOUSSIN

Contributors: CNRS-IRCELYON, CNRS-ICARE, BUW, IfT, CTG, Belgian Road Research Centre (BRRC), Aristotle University of Thessaloniki (AUTh-LHTEE)

Main Objective: Determine the field site and the campaign strategy

One of the key actions of the LIFE+ Photopaq project is to demonstrate on field the efficiency of photocatalytic materials to contribute to an improvement of the air quality. Hence, a specific strategy must be defined to do make perceptible the change in air composition induced by the use of these materials.

Expected results:
1/ - General protocol of the field study
2 /- List of field requirement to be transferred to I1 and I2 actions
Indicators: Number of instruments deployed on the field.
3 /- Define parameters to be measured
Indicators: Gaseous species, Particulate matter and Light spectrum,
4 /-Define spatial and temporal distribution of the measurement
Indicators: Number of stations implemented (2)
5 /- List of parameters to be monitored to be transferred to P4 action and involved partners
Indicators: Monitoring of the parameters is completed

Means of verification:
Reports for meeting preparation, Project meetings (see minutes), e-mailing.
Every morning: field site meeting during campaign.

Description of the action done 01/01/2010 – 31/01/2012

The discussion about the field strategy has started 5 months earlier than expected in the proposal. All opportunities of interactions among partners have been taken through program meetings, e-mail exchange and bilateral working session.

It is decided that a comparison of the effect of active surfaces should be with one of the "normal" surfaces as the basic principle of the PhotoPaq field campaigns.

The physical and chemical parameters to assess this effect have been identified:
- Gaseous species : ozone, NO, NO_2, nitrous acid, major hydrocarbons and oxygenated volatile organic compounds
- Particulate matter : PM_{10}, $PM_{2.5}$, organic fraction aerosol, nitrate fraction of the fine aerosol, sulphate fraction of the fine aerosol
- Light spectrum, wind speed and direction, temperature, relative humidity, rainfall (if applicable)

This list has been transferred to action P4 for the quality control required by our strategy.

Two strategies have been evaluated:
(1) Monitor the targeted pollutants before and after the application of the active material
(2) Monitor the targeted pollutants at the same time in two very comparable locations equipped and not-equipped with the active material.

Due to the highly variable nature of atmospheric composition in urban area it has been considered that the first approach would have required very long time measurement series (several months at the least) to expect any statistically relevant results. To better account, the chemical efficiency of the deployed photocatalytic material, the latter strategy has been chosen.

Tunnel strategy

The Brussels Tunnel has been found compatible with this approach. The specific strategy elaboration for the first field site and the implementation has been considered to require more time than the two months initially foreseen in the project agenda. As a consequence, it has been decided to start this part of the action P3 in advance. In particular, a

highly detailed visit of the tunnel has been organised to choose the best tunnel section with respect to surface-to-volume ratio, car flow spatial regularity, microscale aerology and instruments deployment. A 70 meter long section has been targeted for the September 2011 campaign.

A first measurement site has been equipped upstream the treated section (front station) while a second has been installed downstream (main station). A double strategy has been adopted: i) comparing front and main station data ii) comparing data recorded during irradiation period and dark period (as the depolluting material needs light to be effective).

In order to better account for the efficiency of the studied material a second tunnel campaign is planned for spring 2012. The same strategy is planned but for an increased length of the tunnel section equipped with a more intense new lighting systems.

Open field strategy

The choice of the second field campaign site has been the subject of many investigations. With the help of satellite imaging, the information available from the civil engineering companies in charge of the related urbanisms projects and information available to the consortium many potential sites have been carefully studied. Eventually a field site in southern Europe (Bergamo). Here a dual field site with high surface-to-volume ratio will be constructed (based on existing industrial facility) and equipped in an urban area.

About the open field site campaign.

While it has been forecasted to conduct measurement in both the northern and the southern Europe, this strategy does not seem to bring additional demonstrating clues anymore. Indeed, from the P1 and P2 actions the effect of sunlight has been very well characterised and field campaign would not bring additional evidence or parameterization. On the contrary, it seems now obvious that finding adequate site with suitable surface-to-volume ratio and accounting for micro-aerology is really one of the key points of the demonstrating process. In consequence, based on the P3 actions work, the consortium has decided to focus the PhotoPAQ field campaign in investigating this latter category of parameters.

Steps of the implementation of this action:

- January, 13th, 2010 (Lyon): Special session on general discussion of the field strategy to adopt, during the kick off meeting:
- January, 13th, 2010 (Lyon): Informal meeting LISA-ITCG : Browsing of field site possibility among Italcimenti sites
- July, 16th, 2010 (Brussels): First visit of the Brussels Tunnel
- July, 16th, 2010 (Brussels): Report on Field studies scientific strategy and implementation during Management meeting
- July, 16th, 2010 (Brussels): Special session on outdoor field site during Management meeting
- July 2010 – September 2010 : Study of potential outdoor site in Brighton
- January, 31st, 2011 (Lyon): Report on Field studies scientific strategy and implementation during Management meeting
- February, 1st, 2011 (Lyon): Special session on outdoor field site during Management meeting
- February 2011: E-mail exchange to define the sampling strategy
- March 2011: Study of potential outdoor site in Lyon
- March 2011: Study of potential outdoor site in Strasbourg
- June, 6th, 2011 (Brussels): LISA special visit to the tunnel
- June 2011 – July 2012: Study of potential outdoor site in Metz
- June 2011: Field site strategy and requirements informal report distributed by LISA
- June 2011: Transfer of parameters to be qualified to P4
- July, 4th, 2011 (Brussels): Special meeting on tunnel strategy

- July 2011: Transfer field requirements to be qualified to I2
- November 2011 – January 2012: Study of potential outdoor site in Metz
- January, 27st, 2011 (Thessaloniki): Special session on outdoor field site during Management meeting

Gantt diagram: Starting date 01/01/2010 Ending date 31/09/2013:

		Results																							
Indicators or precise activities list	Year	1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
General protocol of the field study																									
Number of reports to the partners (pre results to follow up, define the parameters to measure....)	Planed																								
	Actual																								
List of field requirement to be transfered to I1 and I2 actions / Define parameters to be measure																									
Number of instruments deployed on the field.	Planed																								
Gaseous species, Particulate matter and Light spectrum	Actual																								
Define spatial and temporal distribution of the measurement																									
Number of stations implemented (2)	Planed																								
	Actual																								
List of parameters to be monitored to be transferred to P4 action and involved partners																									
Monitoring of the parameters is completed	Planed																								
	Actual																								

Deliverables (vi): (deadline February 2012): The deliverable is available on the appendix N°9.4.

Description of the actions for the next period: 31/01/2012- 31/09/2013:

Our experience from the last month has shown that the work on the field strategy is clearly deeply linked with the field actions. Indeed adjustment of the field strategy has to be carried out until the very last days before the campaign to take advantages from local opportunities. Considering that the agenda for field actions has been extended, an extension of the P3 action until September 2013 is required.

5.1.5. Action P4: Instrumentation Quality Insurance

Beneficiary responsible for implementation**:** BUW – Dr. Jörg Kleffmann

Contributors**:** CNRS-IRCELYON, CNRS-ICARE (Orléans), IfT (Leipzig), BRRC, CTG, Paris12-LISA (Paris)

Main Objective: The instrumentation's protocols for the field implementation, the calibration and thus the quality insurance have been implemented.

Expected results:

1/- Definition of the instruments used
Indicators: High quality (precision/accuracy) instruments to be used in the different actions have been selected (see results from P1, P2 and I2 actions).
2/ - Quality insurance

Indicators: Confirmation by the successful results from the intercomparison exercise. Well recorded long time experience of the involved groups with quality insurance.

3/ - Intercalibration exercises

Indicators:

- Duplicate NO, NO_2, HONO and CO_2 instruments have been successfully intercalibrated for both tunnel campaigns (differences <10%, in between the combined accuracy errors of both instruments).
- Still under evaluation: HCHO, carbonlys, particle number, particle mass, particle composition
- Unsuccessful intercomparison: CO, VOCs (one instrument failed) and THC (both instruments failed*)*

Means of verification:

Reports / deliverables

Project meetings (see minutes)

Several e-mail exchanges

Exchange of calibration standards during the I2 campaigns

Successful results from the intercomparison exercises, published in:

- Project reports (midterm report, see below)
- Publication in AMT (Atmos. Meas. Tech., 2012, 5, 149-159,) on the NO_2 interferences

Planned publications:

- Publication in AMT on the HONO intercomparison in the smog chamber
- Further publication in AMT on the I2 intercomparison after finalization of the data evaluation

Description of the action done 01/01/2010 – 31/01/2012

All the instruments to be used in the tunnel campaign were defined in close co-operation with action P3 during different project meetings. Duplicate measurements of the following species were defined for the tunnel study: CO, CO_2, NO, NO_2, HONO, HCHO, VOCs, carbonlys, particle number, particle mass, particle composition, meteorology. Duplicate instruments were chosen, to ensure high precision of the concentration differences between the two tunnel sites caused by photocatalysis.

In addition, when using similar instruments, possible interferences, line artefacts, etc. will not significantly affect the concentration differences.

1) Definition of the instruments used:

Starting date: January 2010

During the kick-off and during the first management meeting in Brussels in 2010 the different instruments to be used during the tunnel campaign were defined in co-operation with action P3. Since the photochemistry of the atmosphere and the subsequent formation of harmful photo-oxidants, like ozone (O_3), is controlled by the abundance of VOCs and reactive nitrogen oxides (NO_y: NO, NO_2, HONO, etc.), and since both groups of trace gases show also direct negative health effects (for example: NO_2, HONO, aldehydes, aromatics,...), the instrumentation will focus on these harmful trace gases. In addition, several particle instruments (e.g. two aerosol mass spectrometers) were chosen to quantify potential reduction of secondary organic particles.

Especially, the photochemical degradation of NO_2 observed on photo-catalytic surfaces, is of high importance to meet the annual threshold limit value of 40 µg/m^3, which was implemented in Europe in 2010. Thus, the interferent-free measurement of NO_2 is of high importance. In addition, since nitrous acid (HONO) was identified as a potential product of the photocatalytic degradation of NO_2, and since HONO has carcinogenic properties, the instrumentation in smog chamber and field studies will also include this harmful species.

Thus, during the initial phase of the PhotoPaq project, especially the instruments to be used for NO_2 and HONO were carefully intercalibrated as part of action P4 to identify potential interferences.

a) NO_2:

It is well known that commercial NO_2 instruments in network stations using molybdenum converters can show strong positive interferences against other NO_y species. In addition, during recent years BUW identified yet unknown negative interferences for photolytic NO_2 converters, which are used to overcome the interferences of the molybdenum converter instruments. In a recent intercomparison exercise at a kerbside station, interferences of molybdenum converter instruments were however found to be mainly caused by freshly emitted HONO (Villena et al., 2012). In contrast, the negative interferences of photolytic converter instruments were found to be of much higher significance under conditions close to emission sources (kerbside/tunnel). Since HONO was determined by two LOPAP instruments during action I2, it was decided to use two standard molybdenum NO_2 instruments in the tunnel (I2) and to correct the data by the known HONO interference.

However, for the field campaign (I1), for which photochemically formed NO_y and their interferences in standard chemiluminescence instruments will get important (Villena et al., 2012), other NO_2 instruments with photolytic converters and a new NO_2 LOPAP instrument will be applied.

b) HONO:

During the first PhotoPAQ management meeting it was proposed to use two identical validated HONO-LOPAP instruments for the two comparative measurement sites for each field campaign during PhotoPaq. This is a modification to the proposal, in which besides one LOPAP instrument the NitroMac instrument from LISA should be used for detection of HONO. However, after the submission of the proposal also CNRS-Orléans has now access to another LOPAP instrument. For comparison, the use of two identical instruments is to be preferred.

2) Quality insurance:

Starting date: September 2010

All partners carefully checked their instruments used in the P and I actions. In addition, all groups used certified calibration standards, which were in addition exchanged and intercompared during both tunnel campaigns. The concentration differences of the finally evaluated species during the tunnel campaigns were <10 % (typically <5 %), which demonstrates the high quality of the data. After harmonization, very high agreement and precision (1-2 %) was observed for the finalized data (R^2 >0.95 for all correlation plots). Interferences for the used standard NO_2 instruments were recently quantified. Main interfering compound HONO was quantified in the tunnel and thus, can be corrected for. The systematic errors in the NO_2 data caused by the HONO interferences was <5 % under the tunnel conditions.

3) Intercalibration exercises:

Starting date: May 2010

The two HONO LOPAP instruments used in the tunnel campaign were recently intercompared in the international FIONA campaign (http://euphore.es/fiona/campaign.html) in the large outdoor EUPHORE simulation chamber in Valencia, Spain. This formal blind intercomparison is still under evaluation, and the final results will be available mid 2012. Good agreement of the two LOPAP instruments later used in action I2, with the DOAS reference technique was observed, especially under conditions which are similar to the tunnel measurements.

In addition, interferences of the commercial NO_2 instruments used in the tunnel were recently determined under kerbside conditions (Villena et al., 2012), enabling a correction of the tunnel NO_2 data (I2).

All duplicate instruments were intercalibrated during the I2 campaign in September 2011 in the Leopold II tunnel in Brussels. The intercomparison data for CO_2, NO, NO_2, HONO is already finalized and a very successful intercomparison was obtained, with absolute differences <10% between each duplicate instruments. In addition, after harmonization, very low precision errors between the two sites of <1-2 % were obtained, which will be important input data for the data evaluation of action I2. The intercomparison of data for HCHO, other carbonlys, particle number, particle mass, particle composition is still under evaluation. However, for CO and VOCs (one of the duplicate instruments failed) and THC (both instruments failed), no intercomparison results are available.

Steps of the implementation of this action:

- Definition of instruments (2010)
- HONO intercomparison in a smog chamber (May 2010)
- NO_2 intercomparison in kerbside station (2010)
- Data quality insurance (start September 2010, with action P1)
- Intercomparison exercise in the tunnel (May/June and September 2011).

Gantt diagram: Starting date 01/01/2010 Ending date 31/09/2013:

		Results																							
Indicators or precise activities list	Year	1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
deployed																									
According to the project goal definition of important trace species to be measured Project meetings	Planed																								
	Actual																								
Quality insurance																									
Long time experience of the involved group with quality insurance Exchange of calibration standards Results from the intercomparison exercise	Planed																								
	Actual																								
Intercalibration exercise																									
Results from the intercomparison exercises published	Planed																								
	Actual																								

Deliverables:

No deliverables were planned in the proposal, however, the actual deliverables are:

- Definition of instruments for the I2 campaign in Brussels
- Publication in AMT on interferences of commercial NO_2 instruments to be used for the correction of the tunnel data
- Validated (smog chamber) HONO measurements
- Successful intercomparison for CO_2, NO, NO_2 and HONO, other data still under evaluation
- Validated and harmonized data for both tunnel stations to be used for data evaluation of the photocatalytic decomposition of pollutants in action I2

Difficulties met and solutions brought:

- The NO_2-LOPAP instrument planned to be used in I2 was not in operation in September 2011. Thus, only the two standard chemiluminescence instruments were used. However, data

were corrected using the experience from the interference study (Villena et al., 2012). Corrections were typically <5 % in the tunnel.
- The intercomparison for CO, VOCs and THC were not successful since one or both of the duplicate instruments failed. Intercomparison will be repeated in the next tunnel campaign.

Description of the actions for the next period: 31/01/2012- 30/09/2013:
Definition of instruments: All instruments to be used in action I1 will be defined.
Quality insurance: Continuous quality check of the instruments used in P1, P2, I1, I2.
Intercalibration exercises: Finalization of the intercomparison data from the first I2 tunnel campaign for HCHO, carbonlys, particle number, particle mass, particle composition: the intercomparison for CO, VOCs and THC will be repeated in the next I2 tunnel campaign, in addition to the other instruments: all instruments used in the I1 action in Bergamo will be intercompared again at the I1 field site.
Publication of the results on workshops (e.g. Corsica), conferences and international journals.

5.1.6. Action I1: In situ monitoring campaign – 1

Beneficiary responsible for implementation**:** CTG

Contributors: All other groups

Main Objective: The main objective of this action is to acquire data (weather, pollution …) relative to an adequate urban outdoor site where a cement-based photocatalytic product is applied and to assess the impact of this application on the local pollution level.

Expected results:

To define a protocol to carry out a monitoring campaign in a typical urban environment
Indicator: Protocol implemented for the outdoor campaign
To build a de-polluting site, by applying photocatalytic cement based materials
Indicators : Field site campaign conducted
To collect data based on the defined monitoring campaign methodology
Indicator: Collection of the field site data

Description of the action done 01/01/2010 – 31/01/2012

As already announced, this action has been shifted toward the end of the project, without any consequence on the overall project organisation and workflow. The actions done up to now lead to define a protocol to carry out a monitoring campaign in a typical urban environment.

The main actions were to define the ideal monitoring site conditions, to identify corresponding sites and to make them validated by partners. The back and forth discussions finally led to abandon the idea to lean on renovations and to build our own experimental site.

The definition of requirements has been initially done regarding a street with canyon profile. Those initial requirements have been defined based on what is written is the project proposal, on prescriptions done during the first meetings by partners and by our own knowledge on air pollution monitoring.
The most relevant are:
-Photocatalytic surface applied
-Geometry of the surface
-Type of worked completed
-Pollution level

-Influence of the loca traffic
-Local Wheater
-Influence of building and site geometry
-And ability/easyness to install monitoring equipments

From the characteristics thus defined, the search for an optimal site has been led in collaboration with commercial departments of local subsidiaries of Italcementi Group in France (Ciments Calcia) in Belgium (CCB) and in Italy (Italcementi). This work involves about 10 persons from Italcmenti Group. The work mainly consisted in canvassing and in organising meetings either internal (about 4 meetings) or with public administrations either to lean on an already existing renovation project or to generate it (about six meetings). To help in presenting the project and the above requirements a powerpoint presentation has been transmitted to the various involved local subsidiaries of Italcementi Group.

Main actions consisted in organising meeting and phone conferences and sending emails. The discussion with public administration (between initial contact and tangible proposal) usually spread out during 6 months.This task has been initiated early compare to what have been planned in the project proposal to take advantage that the tunnel site (task I2) was already chosen.

Three sites in France and three in Italy have been identified during the period. For the most promising ones, data have been collected (geometry, meteorological data, traffic and pollution level) and presented to partners for validation. None of them have been validated because all the requirements were not fulfilled and in particular for what concern the possibility to apply the photocatalytic product on the façades. This difficulty arises from the fact that façades of the sites didn't belong to the public administration but to separate private owners which makes impossible any negotiation.

The discussions during Management meeting in Thessaloniki (23-26th of January 2012) have led to change the specification of the site and to turn to isolated squares (one with and one without photocatalytic material). Then a disused industrial site owned by Italcementi in Bergamo (Italy) has been identified (Via David). Discussions are in progress with manager of Italcementi to obtain the authorisation to install an experimental site there. In the same time discussions are in progress to fix the experimental protocol: either two campaigns (one before, the other after) or divide the area into two zones (one with and one without photocatalytic product). Moreover CTG is considering the possibility for a precampaign to acquire most relevant data as possible on the site.

The other actions (building of the experimental site, application of the product and monitoring campaign) are not yet started. They will be organised as soon as the site and the measurement protocol will be validated.

<u>Steps of the implementation of the action I1:</u>

To fulfil this main objective the following steps are required:

1. To determine the requirements for the construction site towards photocatalytic materials and related parameters (orientation, light intensity …)
2. To identify the monitoring site (Italy or France) corresponding to the previously defined requirements
3. To collect preliminary data (geometry, weather, pollution level, traffic…) on the identified site which could be used as input for modelling
4. To define a protocol to carry out a monitoring campaign in an urban environment. If existing data are not sufficient a ante operam monitoring campaign can be organised
5. To install cement-based photocatalytic products
6. To organise a monitoring campaign before the installation/application of cement-based photocatalytic products

The step 1 serves as basis to take contact with public administrations. The expected result is to be informed of adequate site renovations and availabilities for applying photocatalytic product.

Gantt diagram: Starting date July 2012 Ending date 31/12/2013

		Results																							
Indicators or precise activities list	Year	1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
To define a protocol to carry out a monitoring campaign in a typical urban environnement																									
Individuation of the monitoring site	Planed																								
	Actual																								
Definition of the monitoring site conditions	Planed																								
	Actual																								
Identification of the monitoring site	Planed																								
	Actual																								
To build a depolluting site, by applying photocatalytic cement based materials / Field campaign																									
Monitorting campaign before the installation/ application of cement based photocatalytic products	Planed																								
	Actual																								
Installation/ application of cement based ante operam monitoring results	Planed																								
	Actual																								
To collect data based on the defined monitoring campaign methodology																									
Monitoring campaign after the installation of cement based photocatalytics	Planed																								
	Actual																								
Collection/ elaboration of rouh data	Planed																								
post operam monitoring results	Actual																								

Deliverables :

None are planned on the initial proposal.

Difficulties met and solutions:

- The main difficulty in looking for the requested site is to find a real urban place able to fulfil the main requirement especially regarding the applied surface and the covering of façades. Anticipating those difficulties, we put forward this task. Even if this solution was not successful it allow us to change the strategy by changing the requirements.
- The most recently arising difficulty is due to the fact that a second measurement campaign in Brussels tunnel has been decided. This will involved an increase of the expenses for the I1 site and thus a decrease for the I2 site.

Description of the action for the next period: 31/01/2012- 31/12/2013

Next actions will be to:

To obtain final authorization from Italcementi Group to use the site Via David.

To finalize in collaboration with other partners the measurement protocol

To collect data on the selected site in Bergamo (through available measurement or through specific measurements)

To optimize the application on the basis of modelling result

To finalize the measurement protocol

If this site would not be selected or available we will go to other disused sites that allow better flexibility to protocol requirements.

5.1.7. Action I2: field campaign in Brussels tunnel

Beneficiary responsible for implementation**:** BRRC

Contributors: All partners

Main Objective: In situ monitoring campaign _2

The Action I2 deals with one of the two field campaigns to demonstrate the photocatalytic effect on the air quality. The Leopold II tunnel in Brussels was taken as field site. The objective of I2 is the demonstration of the photocatalytic efficiency and the determination of the most important parameters which have to be fulfilled in the case of a tunnel application.

Expected results:
1/ - A protocol to carry out the monitoring campaign in a tunnel environment.
Individuation of the monitoring site (logistical as well as technical).
Definition of the monitoring site conditions (geometry, level of pollution, traffic, ventilation,…).
Identification of parameters for the measuring campaign.
Indicator: Protocol implemented

2 / - The realisation of the field trial: application of photocatalytic materials as well as installation of lighting system in tunnel.
Identification of the lighting system with prescriptions towards efficiency and disturbance of driver.
Identification of contractor in order to install the material and the lighting system and to prepare the technical room for the measuring campaign.
Identification of optimal painting device in order to install the material in the tunnel.
Installation of lighting system and product.
Indicator: Installation of the lighting system and the photocatalytic material

3 / -Data collection during the pre- and main monitoring campaigns in June and September 2011
Installation of the equipment.
Collection/ elaboration of raw data.
Comparison and post operam evaluation of monitoring results.
Indicator: Collection of the field site data

Means of verification:
Data provided to the partners of the project through mail and internet (PhotoPAQ website, data base provided by partner CNRS-LISA, see the dedicated site).
Log book of the measuring campaign, data collected on the internal site, presentation of the results at the 3rd management meeting in Thessaloniki (24-26th of January, 2012). The logbook is available in the appendix N°13.1 or the intranet website.

Description of the actions done 01/01/2010 – 31/01/2012

Due to practical reasons, it was decided at the kick-off meeting in Lyon (13-14 January 2010) to have the field campaign in the tunnels of Brussels (action I2) before the field campaign in the canyon street (action I1). This shifted the application period from year 3, trimester IV to year 2, trimester IV.

The determination of the exact field trial section was done in different steps. First, a general impression of all partners was obtained during the first management meeting of July 15th and 16th 2010 through discussion during the meeting and a visit of the tunnel. Consequently, data has been collected in order to be able to give an estimation of the reduction through modeling (I3) and in order to develop the field strategy (P3). Following data were collected:

- Geometry of the tunnel: plans have been provided and measurements were done inside the tunnel. These documents are available in appendix N°13.2
- Level of pollution (NO_x) from the continuous measurements which are done by the BIM-IBGE (Brussels environmental institute).

- Amount of traffic by measurements done by the Brussels ministry of Transport and Mobility
- Ventilation schemes. These documents are available in the appendix N°13.4
- Pollution of the surrounding through contacts with BIM-IBGE.

In November 2010, a meeting between BRRC, CTG and its local subsidiary CCB in Belgium took place to discuss the practical aspects of the tunnel renovation process, and to set up the tender specifications. The minutes are available on the appendix N°13.6: these practical issues were further discussed during the 2nd PhotoPAQ Management meeting held on the 31st of January and 2nd of February 2011 in Brussels. During that meeting the results of the initial modeling (by LTHEE) were also presented.

A pre-campaign was organized in the tunnel (measurements by BUW and BRRC) in order to get the first impression on the conditions in the tunnel, to quantify the pollution level (NO_x and CO_2), to quantify NO_x/CO_2 ratios before renovation (for comparison with the September campaign) and to identify the increase of pollutants by emissions in the selected tunnel section. This pre-campaign made it possible to define a 'tracer'. The results have been reported during the tunnel implementation meeting: the 3rd Management meeting (with all partners) held on July 4th 2011 in Brussels. A report on the pre campaign is available on the appendix N°13.3

The lighting was provided through DISANO, an Italian company which had already the necessary experience on the installation of photocatalytic lighting in a tunnel in Rome. The demands asked to them were the determination of the optimal placing of the lamps, the calculation of the light intensity and the risk of interference of the lights with the users of the tunnel (cars and motorcycles). The direct contacts were made through CTG, but final approval was done by the BRRC in close collaboration with the Brussels' Government in order to assure the safety of the tunnel users. The offer and results of the calculation were transmitted through mail (08/07/2011). The order has been placed on the 20th of July 2011.

Since special safety demands are applicable for the workers in the tunnel, the contractor VSE which is already assigned for the maintenance of the tunnel was taken as contractor for the application of the photocatalytic product and for the installation of the lighting. This allowed us to have a more flexible timing and enabled the fast installation of the material and lighting and the preparation of the technical room for the measurement equipment. Specifications were written and a tender was obtained to carry out the works.

The planning and details of the installation were discussed during the tunnel implementation meeting on the July 4th 2011 in Brussels. A detailed working plan is available appendix N°13.5. The Brussels' Government as well as the contractor VSE were present at this meeting. An action plan was set up. Details are given in the minutes of the meeting.

Prior to the application of the product, a trial was done at the premises of VSE (on 15/07/2011, appendix N°13.8) in order to find the correct painting equipment and in order to transfer the knowledge from CTG to the contractor. This was done in the presence of technical people of CTG and BRRC. At the same moment, the lamp armature was tested.

The strategies of the measurements as well as the type of pollutants to be measured are reported in activity P3. Within this action, also prescriptions for the installation of the sampling lines were provided to BRRC and VSE.

The treatment of the data and calculation of the results was supervised by CNRS-LISA under P3.

Summary of monitoring results

1) Pre-campaign of June 2011

In the pre-campaign (from 14th till 22th of June 2011) measurements of NO_x and CO_2 were performed at both test sites (front and main station) to quantify the pollution level and the NO_x/CO_2 ratios before renovation of the tunnel section. Furthermore, the incidental increase of pollutants by emissions in the selected tunnel section was evaluated.

The results revealed that the two sites are similar in terms of pollution level with a high correlation and good agreement between concentrations at both sites. Only for CO_2 there is a statistical significant increase of the difference during rush hours of ca. maximum 5%. For NO and NO_2 the "noise" of the difference is about 5% which is related to the precision of the two intercalibrated instruments. Hence, smaller differences in concentration between both stations cannot be detected.

The ratio NO_x/CO_2 can also be used to calculate emission indices (EI = g X/kg fuel burnt, e.g. EI(CO_2) ≈ 3150 g/kg fuel. This ratio will change if photocatalytic degradation of NO_x occurs (see later for September campaign). For the pre-campaign the EI(NO_x)-value was about 7 g/kg, which is reasonable and with only small differences between both sites. The calculated NO_2/NO_x-ratio (caused by direct emissions) however, turned out to be quite high (ca. 27%) which could be caused by the high diesel contribution in the fleet composition (for Belgium). Overall, the pre-campaign was successful indicating the differences between both measuring stations are small and that changes above 5-10% (owing to photocatalytic activity) would be detectable with the "front-main station" approach using "on/off" modulation of the UV lighting.

Appendix13.9

2) Main campaign of September 2011

Using the strategy and types of pollutants reported in action P3, a two weeks measurement campaign was held between 9th and 23rd of September. The first days were used to intercalibrate the instruments placed in the main station and in the front station, see action P4. The main results for the different pollutants are given below.

a) CO_2

Except for the rush hour peaks, once again perfect agreement was obtained between both sites. Hence, without further chemistry, the same pollution level would be expected for both stations.

b) NO_x (NO and NO_2)

A similar observation as for CO_2 is made for NO_x. Even more, in west wind, high wind speed situations (when traffic is present), NO_x(main) is higher than NO_x(front). For east, low wind periods concentrations at both sites are the same. These qualitative observations are also confirmed by a quantitative evaluation using the NO_x/CO_2-ratio. If there is reaction, NO_x/CO_2(main) should be smaller than NO_x/CO_2(front) (see above). However NO_x/CO_2 ratios were approximately equal for both sites (ca. 2.8 and also similar to the pre-campaign), leading to the conclusion that no photocatalytic reduction of NO_x is observed (or that it is below 2% and thus not measurable in this configuration).

c) HONO

For HONO (nitrous acid) strong differences are observed between the front and main station in west, strong wind periods (with traffic), with no influence of the lamps being on or off.

Hence, there is no photocatalysis of HONO observed in the tunnel, but there could be a heterogeneous dark formation of HONO on the tunnel walls (for west wind conditions) at the front station owing to the "dead" corner present at this site. This could point at a problem with the geometry or set-up of the tunnel campaign

d) HCHO

The results for HCHO (formaldehyde) show variable differences between both sites with concentrations at the main station mostly being larger than at the front station. Especially when switching the lamps on/off steps in the concentrations of HCOH are apparent, which indicate photocatalytic formation of HCHO by the tunnel walls.

e) Other elements measured in the tunnel: Carbonyls (acetaldehyde,…), VOC's and PM

It was not possible to come to conclusions for these elements since there were some unexpected results. So were the results for the aerosols high during periods of low traffic, which could indicate the entrance of ambient air in the tunnel in those periods. This will be looked at more carefully during the second campaign by measuring the wind speed and direction in the ventilation shaft.

Steps of the implementation of the action I2

The detailed planning of the first tunnel campaign was as follows:

- 14-22 June 2011: pre-campaign
- July 5th 2011: order towards VSE
- July 15th 2011: pre-test painting at VSE
- July 20th 2011: order towards DISANO (lighting)
- August 22nd – September 9th 2011: cleaning of tunnel vault, application of material, installation of lighting system and organization of technical room
- September 9th – September 23rd 2011: measuring campaign

Gantt diagram: Starting date 01/01/2011 Ending date 30/09/2012:

		Results																							
Indicators or precise activities list	Year	1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
To define a protocol to carry out a monitoring campaign in a typical urban environnement																									
Individuation of the monitoring site ((logistical as well as technical) Definition of the monitoring site conditions ((geometry, level of pollution, traffic, ventilation,…) Identification of the monitoring site (Belguim)	Planed																								
	Actual																								
To build a depolluting site, by applying photocatalytic cement based materials																									
Identification of the lighting system Identification of contractor in order to install the material and the lighting system Identification of optimal painting device Installation of lighting system and product	Planed																								
	Actual																								
To collect data based on the defined monitoring campaign methodology																									
Installation of the equipment Collection/ elaboration of raw data Comparison and post operam evaluation of monitoring results																									
	Actual																								

Difficulties met and solutions brought:

- Tunnel section was not painted entirely, but only about 70 m of planned 90 m
- No 'burn-free' period was foreseen for the photocatalytic material: due to the tight schedule of placement of the material and the lamps, the material could not be activated by the UV-light prior to the measuring campaign.

- Misaligned orientation of lamps at beginning of main campaign: change of lamps placement
- Light intensity was lower than expected. This could be one of the main reasons together with the lack of activation period and the too short tunnel section for the low photocatalytic effect.
- Defect of one CO_2-sensor, but not a problem caused by the perfect similarity of both sites (the down-wind data can be used)
- THC-sensors (both) and CO (one) failed

Description of the actions for the next period: 31/01/2012- 30/09/2012

A second measuring campaign will be carried out in May or June 2012. Prior to this a small test will be carried out in the tunnel in order to see if the photocatalytic material can be re)activated. The second measuring campaign will imply following steps:
- Contact with Brussels Region in order to get the approval for a second campaign
- Indication of the enlarged test site: visit of the tunnel by CNRS-LISA on the 9th of February (technical room) and by BRRC on the 15th of February (tunnel).
- New specifications towards the lighting system (January-March 2012): through mail
- Preliminary tests (lab scale) to see whether the tunnel surface can be activated under the tunnel conditions with UV (BRRC, March 2012)
- New specifications towards the contractor (March 2012)
- Application of the material, installation of the lighting system: April 2012
- Activation period of the material: April-May 2012
- Measuring campaign: May-June 2012

5.1.8. I3 Numerical modelling campaign and data analysis

Beneficiary responsible for implementation**:** Aristotle University of Thessaloniki (AUTh-LHTEE)

Main Objective: The main objectives of Action I3 are the following:
Preliminary assessment of the air quality for the greater field trials regions in Italy/France and Belgium
Field site selection and design optimization
Urban de-pollution modeling for the selected field site configurations
Assessment of the measured de-pollution effectiveness of the selected covering materials from the field campaigns
Quality assurance, evaluation and validation of numerical modeling results
Integrated assessment and cost benefit analysis
Indicators: Numerical model done and available on the website
Means of verification
Frequent reporting of the numerical modeling results to the partners during the MC, Technical and Implementation meetings
Presentations of the results in scientific conferences and workshops.
Deliverables

Expected results:

The expected results from Action I3 are essentially numerical modeling results for:

- Field site selection and design
- Expected achievable de-pollution in the field site
- Field measurements analysis and assessment of the de-pollution effectiveness of the selected samples

Indicators: field measurements are collected and assessed

- Numerical modeling technique evaluation and validation

Indicators: Evaluation and validation of numerical modeling results are available on the website

- Integrated assessment and cost benefit analysis in the selected regions of the field sites
  Indicators: Report on cost benefit analysis is available on the website
- The demonstration tool as operational software to be disseminated
  Indicators: tool will be made available online

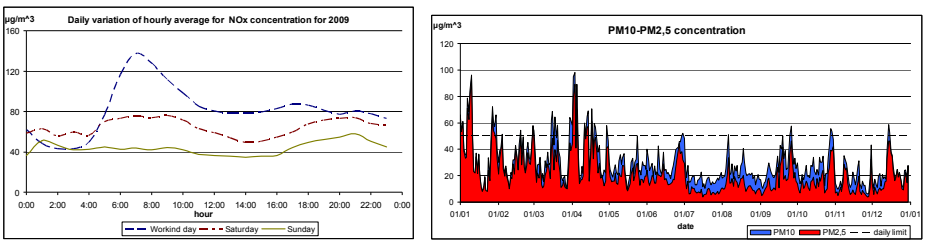
Description of the action done : 01/06/2010 – 31/01/12

The main aims and objectives of this Action are the following:

- To perform a preliminary assessment of the current state of the air quality for the greater regions of the selected location where the field trials will take place.
- To optimise the design of the measuring campaign and assess the potential de-pollution effectiveness of the selected photo catalytic covering materials based on numerical modelling results.
- To assess the de-pollution effectiveness of these materials for the specific cases of the planned field trials by analyzing the data collected during the measurement campaigns.
- To evaluate the numerical modelling results and validate the performance of the modelling methodology which will be employed based on comparisons between numerical results and field measurements via the employment of appropriate statistical methodologies.
- To perform an integrated assessment and cost benefit analysis

As it was already reported during the first reporting period, Action I3 will start on mid-September 2010 and will finish by the end of the project. As a first step, in accordance with the main objectives of Action I3, during the period September 2010 – February 2012 the following actions were completed:

A review of the air quality on the greater Brussels area was first conducted. The tunnel Leopold II is situated on a heavy traffic area of the region and as expected, accumulates high concentrations of air pollutants associated to traffic emissions and especially NO_x. The figure 1 presents the typical annual mean of NO_x and PMs daily variation for 2009 in Brussel, based on data obtained and analyzed from local measuring stations within the frame of the aforementioned review.



(a) *(b)*

Figure 1: Typical annual mean variation of (a) NO_x and (b) PM_{10} and $PM_{2.5}$

Furthermore, a series of preliminary numerical simulations were performed in order to determine the potential effect of the operation of the tunnel's ventilation system on the dispersion and dilution of road traffic emissions across the direction of the vehicle's motion inside the tunnel as well as the distribution of concentration of Nitrogen Oxides (NO_x) along the walls of tunnel, with emphasis on the section which was selected to serve as a test section for the field trials. To this purpose:

- Detailed drawing and blueprints of the Leopold II road tunnel in Brussels were collected, analysed and a 3D Computer Aided Design (CAD) model was generated.

- Based on the 3D CAD model, a numerical mesh was generated (Figure 1) and a mesh sensitivity study was conducted in order to optimise it from computational resources vs. quality of results point of view.
- Detailed data for the direct road traffic emissions inside the road tunnel as well as schematics for the tunnel's ventilation system including the mass (volume) flow rates of the ventilating vanes at each location were collected and analysed in order to be used as input boundary conditions for the preliminary set of numerical simulations.
- During this set of simulations the effect of the vehicles' motion inside the tunnel on the dilution of air pollutants and on their distribution along the tunnel walls was parameterised. More specifically, it was assumed that the velocity of the flow is equal to the velocity of the vehicle's moving inside the tunnel at a height equal to the average height of a passenger car. It was further assumed that no heavy duty vehicles were allowed to enter the tunnel.
- A standard Reynolds Averaged Navier Stokes (RANS) approach, both steady and unsteady, in conjunction with the Standard *k-e* turbulence closure model was applied.

(a) *(b)*

Figure 2: Location of the Leopold II road tunnel in Brussels' city centre (a) and 3D CAD model and mesh (b).

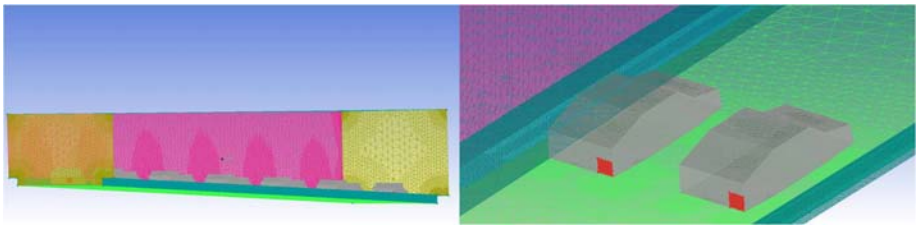
According to the findings of this first set of numerical results:

- Highest concentrations of air pollution as a result of the direct emissions from the road traffic should be expected close to the exits of the road tunnel.
- In any case however the NO_x concentrations inside the road tunnel are particularly high reaching their highest during the morning peak hours.
- There is a strong dependence of the dispersion mechanism inside a road tunnel on the operation of the ventilation system. It has a strong impact on the distribution of the traffic emitted air pollution downwind the tunnel towards the exits where the tunnel air is normally diluted.
- Specific areas inside the tunnel can be adversely affected from a concentration level point of view, depending on their location with respect to the extractors and the injectors of the ventilation.

Upon completion of the first set of preliminary simulations, the results were presented to the partners so that the optimum location inside the tunnel could be selected. However, in order to conduct the measurement campaign several practical needs had to consider for the selection of the test section such as the need to have a control room where the equipment would be placed. In view of these needs and taking into account the numerical results test section of ~90 m was selected, which based on the ventilation schematics provided lays between an extractor and an injector, with easy access from a relatively large control room, suitable for accommodating the staff and the equipment during the campaign.

Further to this first set of numerical simulations, as a second step, the field trial test section which was selected was isolated and the dispersion of traffic emissions was simulated taking into account the combined effect of the ventilation system and the vehicles motion in order to both quantify the expected levels of air pollution during the field campaign and

assess the potential de-pollution performance of the samples which would be tested. During this second series of numerical simulations, the dispersion of traffic emissions was simulated in the field trial test section only, for a period of time which corresponds to the average residence time of the vehicles inside it. Numerical results from the first stage for the velocity and the turbulence profiles at the entrance of the section and the average pressure at its exit were used as inflow and outflow boundary conditions respectively. Based on the information for the traffic flow, the speed and the geometrical characteristics of the vehicles, their average residence time in the tunnel, the number of traffic lanes and the tunnel's length, it was estimated that a total of 12 vehicles are present in the field trial tunnel section, with an average distance of 15 m between two consecutive vehicles. Figure 3 shows the 3D CAD model and mesh which was generated which also includes the presence of passenger cars.



(a) *(b)*

Figure 3: 3D CAD model and mesh (a) of the field trial test section and (b) passenger cars inside the test section

According to the main findings of this second series of numerical results, around 22 % of the emitted pollution is accumulated on the walls. Based on the laboratory results for an expected deposition velocity of 0.2 cm/s the maximum potential achievable de-pollution that should be expected should be ~12%. In addition there seems to be a strong dependency of the dispersion mechanism on the combined complex effect of the operation of ventilation system. The motion of vehicles inside the tunnel on top, promotes strong entrapment and poor dilution, mainly to the flow separation observed at the wall side of the vehicles and the resulting aerodynamic forcing which in turn can lead to a considerable increase in the tunnel wall concentrations.

It should be noted at this point that this study focused mainly on the situation occurring during the morning peak hours. The reason is that although photocatalysis as a phenomenon is relative and can be measured during other times as well, tin order to estimate the socioeconomic benefits arising from the use of photocatalysis as a means for reducing the exposure of the urban population, it is important to take into account what really happens when the most part of the population is traveling through the tunnel, when:

-The vehicles move through at relatively low speeds thus increasing the time of exposure of the drivers

-The emissions are at their highest

-The ventilation system is in operation

Steps of the implementation of the action I3:

- At the time when this 2nd set of simulations were performed, information for the traffic loads were provided only for the morning peak hours, measured during October 2009. In addition to this after the completion of the first phase of the field trial, a 3rd set of numerical results has already been initiated in order to recreate the situation during the entire day, using as input boundary conditions measurements for the traffic load and the wind speed inside the tunnel. The reason for initiating this 3rd of numerical simulations, is the need to evaluate and validate the numerical modeling technique which was applied based on real life measurements

- In addition, after the 1st phase of the field trial in the Leopold II tunnel was completed, the consortium decided to proceed with a 2nd phase, scheduled to take place during May 2012. Hence in addition to the 3rd set of numerical simulations which, as it was pointed out above would serve to validate the numerical modeling technique, a 4th set of simulation will be conducted to account for the 2nd phase of the field trial in the Leopold II tunnel, as additional effort, not initially foreseen. Based on the measurements gathered during this 2nd phase we will be able to assess, from a cost – benefit point of view, the effectiveness of the proposed numerical modeling technique with measurements taken in different geometries within the same tunnel and during different seasonal conditions. Furthermore, having validated the numerical modeling technique as proposed above we will then be able to apply for extended periods of time in order to perform a cost – benefit analysis.
- Based on the measurements which we have already gathered from the 1st phase of the field trial we will assess the expected de-pollution, under the conditions that existed during the period of the 1st phase. After the completion of the 2nd phase of the experiment, we will collect and analyze the measurements in the same way as in the 1st phase. By doing so, we will then compare the existing conditions during the two phases and come up with significant conclusions about what would be the optimum conditions inside the tunnel in order to achieve the maximum de-pollution and what that maximum de-pollution should be.
- Furthermore, based on the fact that a 2nd phase of the field trial will take place in Leopold II tunnel and the corresponding need to proceed with a 4th set of numerical simulations, upon its completion an initial version of deliverable viii, "Numerical modeling results for the optimization of the field sites and the expected achievable de-pollution" will be submitted. Unfortunately, it was not previously possible to submit it, as the need to proceed with a 2nd field trial also resulted in additional activities for this action which are expected to be completed in Spring 2012, following the foreseen schedule for the completion of the 2nd phase of the field trial. It should also be noted that the location for the conduction of the outdoor experiment in Bergamo - Italy, as it was foreseen in the proposal, was only selected during the 3rd MC meeting in Thessaloniki, during the period 24 – 26 January 2012. Hence the first version of the aforementioned deliverable will only include results from the Leopold II field trial. It is therefore suggested to shift the submission of the final version towards the end of the project, when the data from the trial in Bergamo, Italy will also have been collected and analyzed.
- In view of the fact that a site for the outdoor field trial was recently selected, at the moment a thorough review of the air quality in the Greater Bergamo Area is underway. We have already collected a significant amount of historical data for the local meteorological conditions and the urban background concentrations of selected pollutants. In addition, we are seeking to obtain data for the evolution of the traffic fleet and the traffic emissions over the years. This review is expected to be finished by the end of March 2012. Together with the review that has already been performed for the Brussels area, they will form the complete and final version of deliverable vii. It should be noted that an initial version of this deliverable which included the review of the air quality around the Brussels area.
- In relation to the deliverables "ix - Field measurements data analysis and geographic classification", "x - Evaluation and validation of the numerical modeling technique" and "xi - "Integrated assessment and cost benefit analysis"), it should taken into account that their submission is scheduled for the end of June 2013, when the measurements from the outdoor experiment will have been gathered and analyzed.

Gantt diagram: Starting date 01/06/2010 Ending date 31/12/2013

Indicators or precise activities list	Year	Results																							
		1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
To optimise the selection and design of the field sites / Preliminary assessment of air quality																									
	Planed																								
	Actual																								
Collect and analyse the field trial measurement from all selected sites in order to assess the de-pollution effectiveness of the selected photocatalytic samples /site selection and design optimisation																									
	Planed																								
	Actual																								
Evaluate and validate the numerical modelling results based on the measurements from the 2 field campaign / Urban de-pollution modelling + quality assurance, evaluation and validation of numerical modelling results																									
	Planed																								
	Actual																								
Perform an integrated ecomomics assessment and cost benefit analysis of the proposed techniques / integrated assessment and cost benefit																									
	Planed																								
	Actual																								

Deliverables (vii):

In addition the main deliverable for the period (Appendix N°9.5):

1. vii, "Review of air quality measurements and studies for the selected regions of the field sites"

Difficulties and solutions:

Gathering a complete set of data for the review of the air quality from urban background stations. The local hosts however, managed to gather the data required through their local contacts. Delays in the selection of the 2nd field trial site resulted in delays in the submissions of deliverables vii and viii. However, as a solution it was suggested to submit initial versions for these deliverables containing information only about the Leopold II trial and submit the final versions upon completion of the outdoor experiment in Bergamo, Italy.

Delays in the initial version of deliverable viii were also observed due to the fact that the 1st phase of the Leopold II trial was also delayed. As a result it was impossible to obtain detailed measurements for the traffic load and wind speed inside the tunnel to be used as input boundary conditions for the 3rd set of numerical simulation that are currently under way and scheduled to finish by the end April, when the deliverable is expected to be submitted.

Description of the action done 31/01/12 - 31/12/13

-Finalize the review of the air quality over the Greater Bergamo area and the corresponding deliverable (vii).
-Finish the analysis of the field measurements from the 1st phase of the Leopold II field trial.
-Collect and analyse the field measurements from the 2nd phase of the Leopold II field trial.
-Finalize the necessary numerical simulations for the Leopold II field trial (3rd and 4th series of simulations).
-Use the measurements collected and analyzed from the two phases of the field trial in Leopold II in order to evaluate and validate (quality assurance procedure) the numerical methodology applied.
-Submit the initial version of deliverable viii.
-Perform an initial series of simulations for the selected location for the outdoor trial in Bergamo – Italy.
-Collect and analyze the data from the outdoor field trial.

-Use field trial measurements as input boundary conditions and perform a 2nd set of numerical simulations in order to evaluate and validate the numerical modeling methodology for outdoor applications.
-Perform a cost-benefit analysis based both on field trial measurements and numerical modeling results for the socioeconomic benefits arising from the application of the proposed photocatalytic covering materials.
-Develop a demonstration tool as operational software to be disseminated.
-Submit final versions of deliverables ix, x and xi

5.1.9. Action D1 - Website (2010-2013)

Beneficiary responsible for implementation: CNRS-IRCELYON

Contributors: CNRS-IRCELYON

Main Objective: Implementation of the website within the six months following the project's start date.

Expected results:
1/ - Implementation of the website
2/ - Monthly update of the website and the intranet website.

Steps of the implementation of the action:
- The website is online at http://photopaq.ircelyon.univ-lyon1.fr/. The website was done only 3 months after the project starting date i.e., on April 1st.
- The website contains an extranet section where the project's objectives, consortium, images, photoPAQ symposium, PhotoPAQ campaign, press review, newsletter subscription and events are described.
- The website contains an intranet section, where all official documents, contracts, meeting notes and presentation are available to all partners. A guideline (available in appendix N°8) has been made in June 2011.
The Username: photopaq and the password: ph0t0paq
- In June 2011, the PhotoPAQ consortium decided to implement a regular newsletter (every 6 months). The subscription is possible online. The 2 latest newsletters are available in the appendix N°10. We have 96 subscriptions for the PhotoPAQ newsletter.
- Events are updated on monthly basis.

GANTT Diagramm: Starting date 30/06/2010- 31/12/2013:

		Results																							
Indicators or precise activities list	Year	1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Implementation of the website within the 6 months following the project's start date																									
Implementation of the website	Planed																								
	Actual																								
Monthly updated	Planed																								
	Actual																								

Steps of implementation for the next period
- The field campaign's result will be posted under the PhotoPAQ campaign website

- PhotoPAQ newsletters will be distributed on a 6 month basis
- Events will be updated on a monthly basis

5.1.10. Action D2 - Reporting (2010-2013)

Beneficiary responsible for implementation: CNRS-IRCELYON

Contributors: CNRS-IRCELYON

Main Objective: Report providing the status of the project along with the information about the ongoing demonstration activities.

Expected results:
1/ -Recommendation report (at the end of the project)
Indicators: final report "policy guideline"
2/ - Report concerning the monitoring methodology to be adopted in relevant project
Indicators: regular reports, providing the status of the project are available on the website
3/ -Demonstration tool for de polluting action, which can be obtained from the numerical actions.
Indicators: Demonstration tools report.

Steps of the implementation of the action:
- Collection of information to elaborate the first report (mid-term report)

GANTT Diagramm : 31/03/2012- 31/12/2013:

		Results																							
Indicators or precise activities list	Year	1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Annual report providing the status of the project (available on website)																									
Recommendation report	Planed																								
	Actual																								
Report concerning the monitoring methodology	Planed																								
	Actual																								
demonstrating tool for depolluting action	Planed																								
	Actual																								

Steps of implementation for the next period
- The mid-term report, once validated will be available on the website
- Collection of the 6 months internal report
- Elaboration of the "policy guidelines"
- Elaboration of the demonstration report

5.1.11. Action D3 - International dissemination of results (2010-2013)

Beneficiary responsible for implementation: CNRS-IRCELYON

Contributors: CNRS-IRCELYON

Main Objective: International dissemination of results

Expected results:
1/ - Press release and brochures
Indicators: number of brochures distributed and press release
2/ -Organization of 3 international conferences
Indicators: diffusion, publicity, mailing, website diffusion
3/ - Press review articles in scientific journals
Indicators: Number of articles, number of downloads

PhotoPAQ developed its international communication and dissemination plan thanks to the organization of 3 international symposiums, thanks to impact of the field campaign and thanks to the participation to international conferences. During these events, brochures have been distributed and press releases have been collected. The PhotoPAQ's communication plan is punctuated by the campaigns and workshops

a) International symposium

PhotoPAQ consortium participated as a sponsor to the JEP: 2nd European Symposium on photocatalysis 2011 on 29-30 September 2011, Bordeaux Cité Mondiale France. A copy of the acts distributed is available upon request. A copy of the PhotoPAQ webpage on the JEP website is in appendix N°11.1. The PhotoPAQ participation of JEP is defined as one of the 3 workshops that must be organized during its project (validated by Astrale).

> *"Topics of JEP 2011: Fundamental breakthroughs, standardization methods and recent industrial applications. The accurate and standardized determination of the performances of various new materials and devices is a pre-requisite for the design of original photocatalytic materials and the secure development of the photocatalysis market. European and International standards are either published or under study in standardization committees, mixing experts from companies and academics from research laboratories. JEP 2011, September 2011, provides a timely update on research breakthroughs on photocatalytic materials and methods devoted to mechanisms understanding, recent standardization methods, latest applications of photocatalysis, including: air and water purification, hygiene, self-cleaning materials, outdoor and indoor coatings for roads and buildings."*

With an international audience of over 300 innovators, academic experts and business leaders in photocatalysis, JEP 2011 aimed to help bring breakthroughs in the field from laboratory to marketplace. The JEP 2011 program included state of art talks by European leaders in the field and specially tailored poster sessions to promote exchange on the latest results. Bilateral meetings opened an opportunity to exchange with other delegates.

As a sponsor, PhotoPAQ had the opportunity to have an exhibitor stand, with 2 grids (100x170), one table (120x70) and 2 chairs. The PhotoPAQ management team decided to make a short movie on the PhotoPAQ field campaign in order to be a communication support which could be used in the JEP organization. The short movie is available online (http://photopaq.ircelyon.univ-lyon1.fr/PhotoPAQ-campaigns/Indoor-campaign). The impact of broadcasting the PhotoPAQ movie was immediate, attracted by this documentary, many contacts with academics researcher and industrials have been done. The movies have been screened during these 2 days conferences. The pictures of the stand are available in appendix N°11.2 and are available on the website "section images".

Impacts: 250 Brochures (available in the appendix7) have been added in the welcome booklets distributed by the JEP organization committee. Moreover 200 brochures have been distributed by the PhotoPAQ Junior Project manager during the 2 days workshop. The documentary on the first PhotoPAQ field site has been displayed continuously during 2 days.

b) Presentation of the PhotoPAQ project to international conferences

The PhotoPAQ project has been advertised in the following international conferences:

- Workshop on Atmospheric Chemistry: kinetics and spectroscopy, 24-26 February 2010, University of Bayreuth

- Session d'information sur le programme LIFE+, Paris, France, May 2010

- Concrete Day, 21/10/2010 - Workshop « Traiter les pollutions » par la photocatalyse by CCB/Italcementi, Brussels, Belgium.

- 20 et 21 janvier 2011 : Carrefour de la Recherche, Colloque international sur la ville durable et Convention d'affaires Green City - Marne-la-Vallée (appendix N°12.1)

- 2-6 October 2011: 14th International Conference on Harmonization within Atmospheric Dispersion Modelling for Regulatory Purposes/ Kos Island, Greece (appendix N°12.4).

- The participation to the 3rd International workshop on Regional Air Quality Improvement in rapidly Developing Economic Regions 12-13 Nov 2011, Guangzhou, China: Mr Mellouki "Keynote talk" (appendix N°12.2)

  "Following the success of the 1st and 2nd Workshop on Regional Air Quality Management in Rapidly Developing Economic Regions, with the great supports from the environmental authorities and academic institutes in Guangdong Province and the Hong Kong Special Administrative Region, we plan to hold "The 3rd Workshop on Regional Air Quality Improvement in Rapidly Developing Economic Regions" themed by "Environment, Climate and Energy" on 12-13 November 2011 in Guangzhou, China. This Workshop is aimed at building a high-level academic platform for environmental experts, technicians, government and enterprise managers, etc. to communicate their views on recent hot issues related to Environment, Climate and Energy in China and over the world."

- Our partners Itali Cementi, participated to « Benefits and risks of nanotechnologies for the environment » 31 January 2012, Brussels

  "A first Cefic workshop organised in May 2011 confirmed the need of dialogue on real life contributions of nanotechnologies. To build on this first exchange Cefic would like to discuss with you about several other real life contributions of nanotechnologies in major applications such as energy efficient tyres (Michelin), renewable plastics (Vegetal & Mineral Water SAS), performance construction chemicals - key to European sustainability and competitiveness."

  The agenda and the presentation of Mr Gan Luca GUERRINI are available on the appendix N°12.3

c) Communication's impact of the first PhotoPAQ field campaign

PhotoPAQ consortium focuses its communication plan on the 2 field campaigns.

On the 8th September 2011, PhotoPAQ launched by a press conference its first field campaign in the Leopold II tunnel in Brussels from 22:00 to 23:45 on the field site.

The press conference has been prepared and supervised by the National coordination press center of the CNRS. They did the press announcement and spread it through their own network. They worked closely with the consortium and the press service of the Ministry of Transport and Mobility of the Brussels Region.

The press conference started by the Ministry of the Transport and the Mobility of Brussels's talk, and has been followed by the presentation of the coordinator Mr Christian GEORGE and Mrs Anne Beeldens. The press conference continued with the presentation of the instruments deployed on the site, and a visit of the tunnel renovated with the photocatalytic cement. Some pictures of the press conference are available on the PhotoPAQ website.

Impacts: 30 press releases collected (available on the website and in the appendix n°6)
5 TV news (itélé, télématin France2, rtbf info, TV Brussels, ZDF)

Steps of the implementation of this action:

- Elaboration of the brochures and posters. The supplier, who provided the website, did the model of the brochures and posters. The brochure are available on the appendix N°14.
- PhotoPAQ was a sponsor of the JEP 2011: 29-30 September 2011, Bordeaux Cité Mondiale France: preparation of the stand, rent screen, preparation of the PhotoPAQ field campaign, presentation of the PhotoPAQ project during the JEP, distribution of brochures...
- Participation to the 3rd International workshop on Regional Air Quality Improvement in rapidly Developing Economic Regions 12-13 Nov 2011, Guangzhou, China: Mr Mellouki "Keynote talk"
- Organization of the press conference in Brussels in strong relationship with the CNRS press service and the press service of the Ministry of the Mobility and the Transport.
- The press releases have been made are given in the appendix n° and are also available on the extranet website.

GANTT Diagramm: Starting date 01/01/2010 Ending date 31/12/2013:

		Results																							
Indicators or precise activities list	Year	1st Year						2nd Year						3rd Year						4th year					
	Trimester	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
press release and brochures																									
Number of press release (availability of the information...)	Planed																								
	Actual																								
conferences 3 workshops organized																									
JEP																									
Corsica	Planed																								
Lyon	Actual																								
peer reviewed articles in scientific journals																									
Number of articles	Planed																								
Demo-tools (number of dow nloads..)	Actual																								

Steps of implementation for the next period:

- Organization of the PhotoPAQ Symposium in Corsica 14-17 May 2012.
- Organization of the PhotoPAQ colloquy in Lyon in 2013.

5.2. Envisaged progress until next report.

Preparatory actions:

- The P1 actions enable to (i) study the tracers and organics degradation and (ii) operate the newly designed runoff reactor. The organic system studies still need to be performed at BUW and IfT. These laboratory results will be very valuable for the new Brussels tunnel campaign #2 foreseen for May 2012 and for the second outdoor campaign. Due to delays in material supply, hiring students and scientists on time and delays in runoff reactor design and realization, the lab experiments should be continued.

- The results obtained for the P2 actions in all facilities showed a decrease of NOx in the presence of the treated surfaces, which may indicate an effect of TiO_2 on the atmosphere containing this pollutant. The planned tests were all conducted; however, more tests might be requested depending on the reformulation of the materials that might be used in actions I1 and I2.

- The experience from the last months has shown that the work on the field strategy is clearly deeply linked with the field actions. Indeed adjustment of the field strategy has to be carried out until the very last days before the campaign to take advantages from local opportunities.

- All instruments to be used in action I1 in Bergamo will be defined, a continuous quality check of the instruments used in P1, P2, I1, I2 the finalization of the intercomparison data from the first I2 tunnel campaign for HCHO, carbonlys, particle number, particle mass, particle composition, the intercomparison for CO, VOCs and THC will be repeated in the next I2 tunnel campaign, in addition to the other instruments, all instruments used in the I1 action in Bergamo will be intercompared again at the I1 field site, publication of the results on workshops (e.g. Corsica), conferences and international journals.

Implementation actions:

-The action I1 will involve the following action to be achieved: To obtain final authorization to use the identified site, to finalize the measurement protocol, to collected data, to optimize the application …

- A second measuring campaign will be carried out in May or June 2012. Thus, the photoPAQ consortium will enlarged test site: visit of the tunnel by CNRS-LISA on the 9th of February (technical room) and by BRRC on the 15th of February (tunnel), define new specifications towards the lighting system (January-February 2012), do the preliminary tests (lab scale) to see whether the tunnel surface can be activated under the tunnel conditions with UV (BRRC, February 2012), define new specifications towards the contractor (February-March 2012), apply the material, installation of the lighting system: March 2012, do the measuring campaign: May 2012.

Name of the Milestone	Code of the associated action	Deadline	Actual Deadline
Laboratory testing of photocatalytical material	Action P1	30/12/2011	31/12/2013
Built a depolluting site, by applying photocatalytic cement-based materials	actions I1 + I2	30/06/2011	30/09/2013
Collected data based on the defined monitoring campaign methodology	actions I1 + I2	30/06/2012	30/09/2013
Collected data based on the defined monitoring campaign protocol	actions I1 + I2	31/12/2012	30/09/2013
Tests under controlled atmospheric conditions	Action P2	31/12/2011	31/12/2013
Field studies scientific strategy and implementation	Action P3	31/12/2011	30/09/2013
Instrumentation Quality Insurance	Action P4	30/06/2013	30/09/2013
In situ monitoring campaign – 1	Action I1	31/12/2012	31/12/2013
In situ monitoring campaign – 2	Action I2	31/12/2012	30/06/2012
Field site optimization and design	Action I3	30/04/2011	31/12/2013
Integrated assessment and cost benefit analysis	Action I3	30/06/2013	31/12/2013
Geographic classification of expected de-pollution performance	Action I3	31/12/2012	31/12/2013
Operational website	Action D1	30/06/2010	31/09/2010
Reporting	Action D2	31/09/2010 31/03/2013 31/03/2014	Done 31/03/2012
International dissemination of results	Action D3	31/12/2013	31/12/2013
Website communication	action D1	On going	31/12/2013

Indicators or precise activities list	Year	Results																									
		1st Year						2nd Year						3rd Year						4th year					
		I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
C1																									
Effective and constants work flows & Dissemination of information within the project:	Planed																								
	Actual	1			1			2			1			1											
Regular submission, validation, storage and dissemination data	Planed																								
	Actual																								
C2																									
Possiblity to verify the progress and status of the project at any time	Planed																								
	Actual																								
P1																									
Investigate on the influence of Photocatalytic surface films Identification of gas phase and particulate "tracers" compounds Identification of low volatile photocatalytic reaction products /Screening about photoactive materials	Planed																								
	Actual																								
P2																									
Protocols from pilot tests Provide the protocols and techniques for evaluation of the use Impact of the selected materials on the loss of air polluant Identification and characterization of gas phase tracers and particles	Planed																								
	Actual																								
P3																									
General protocol of the field study Define parameters to be measure Define spatial and temporal distribution of the measurement List of parameters to be monitored to be transferred	Planed																								
	Actual																								
P4																									
Definition the instrument to be deployed Quality insurance Intercalibration exercise	Planed																								
	Actual																								
I1																									
To define a protocol to carry out a monitoring campaign To build a depolluting site To collect data	Planed																								
	Actual																								
I2																									
To define a protocol to carry out a monitoring campaign To build a depolluting site To collect data	Planed																								
	Actual																								
D1																									
Implementation of the website within the 6 months following the project's start date	Planed																								
	Actual																								
D2																									
Annual report providing the status of the project (available on website)	Planed																								
	Actual																								
D3																									
press release and brochures conferences 3 workshops organized peer reviewed articles in scientific journals	Planed																								
	Actual																								

6. Financial part

6.1 Putting in place the accounting system

The accounting system being used in this project corresponds to the CNRS financial service available at Lyon (www.dr7.cnrs.fr). As a consequence, the financing monitoring of PhotoPAQ will be made at the best possible level. As coordinator, the CNRS collected the financial statement and the supporting documents on six month basis (as agreed in the CA). The internal procedures (financial, mission reimbursement...) of the beneficiaries' partners are available under request.

The beneficiaries use internal accounting reference for all supporting documents:

1A_ IRCELYON	LIFE08 ENV/F0047 100329
1B_ ICARE	LIFE08 ENV/F0047 OTP 302983/1B1INSIS
2_ IFT	LIFE08 ENV/F0047 R0902600
3_ BUW	LIFE08 ENV/F0047 C0307701A
4 _CTG	LIFE08 ENV/F0047 2006702
5_Auth LHTEE	LIFE08 ENV/F0047 83963
6_BRRC	LIFE08 ENV/F0047
7_LISA	LIFE08 ENV/F0047 10R03011A-CE

Time sheets were collected and submitted for approval to the MoT during the visit. We noticed that all were approved and have been used for this period.

We noticed also that concerning the partner University Paris XII that only the expenses performed by the beneficiaries (i.e., CNRS and Paris XII) are eligible. The partner was informed of this limitation.

1.1. Continued availability of co financing.

The co-financing in this project is associated to the two field campaigns, actions I1 and I2. Despite the fact that the planning of both actions have been modified (see above), again without any impact on the project objectives nor on the workflow, these field studies are currently being organised as expected, underlining the continued availability of co-financing.

1.2. Costs incurred (summary by cost category and relevant comments)**.**

Budget breakdown categories	Total cost in €	Eligible Cost in €	% of total eligible costs
1. Personnel		884684,06	81,7%
2. Travel and subsistence		64607,63	6%
3. External assistance			
Infrastructure			
Equipment	38 798	19 399	3,58%
Prototype		14 639	1,4%
5. Land purchase / long-term lease			
6. Consumables		84 422	7,8%
7. Other Costs		15 120	1,4%
8. Overheads		74630	7%
TOTAL	1 102 271	1 082 872	

Comments on the expenses for the period 01/01/2010 -31/01/2012:

- *Personnel expense category:*

The personnel cost represents 81, 7% of total expenditures declared for this reporting period. This budget category represents the most important part of the expenses at this time of the project. Indeed, the main actions implemented have been the preparatory action, made in the laboratory. During the field campaign in Brussels, scientists have been present even if not declared on the PhotoPAQ project with the timesheet.

-Travel and Subsistence Cost:

The travel expenses represent 6% of total expenditures declared. These expenses include travel and subsistence cost for the management meeting, the field "indoor" campaign, and dissemination actions (JEP, symposiums...)

-External Assistance:

The consortium agreed that each beneficiary will conduct an external audit in its own lab. It is more relevant and the better way to evaluate the efficiency of the use of the Life+ funds. Therefore this amount has not been yet expensed.

-Equipment:

Life+ stickers which will be put on the equipment bought by Life+ funds will be done in the first semester 2012. The design has been elaborated and stickers are in process to be produced.

2 NOx-Analyzer for chemical measurement has been bought by the partners IFT and one laptop for this specific instrument. Another laptop has been bought by BRRC to be used to the instruments during the first field campaign. All these equipments were planned in the initial budget.

As the "outdoor" campaign did not start and is planned for the next period, CTG did not used its budget planned (40 000 Euros)

-Prototype:

As the "outdoor" campaign did not yet start and is planned for the next period, CTG did not

used its budget planned (140 000 Euros) for this action. This amount will be used either for the I1 or I2 second campaign.
Due to delays invoicing of the renovation and lighting installation, BRCC did not declared all the cost faced for the I1 ("indoor campaign). 14 639 Euros, which is the cost for the lighting system has been reported for this period. However 40 000 Euros of invoices (renovation of the tunnel, organization safety preparation, cleaning ...) are still pending; the details of the cost with the contractor (VSE) needed to be clarified.

-Consumables:
The consumables costs represents 7,8% of total expenditures declared for this reporting period, (84 422 Euros). These expenses include mainly chemicals and materials for the preparatory and implementation actions. The production of 200 brochures distributed during the dissemination is under this budget category.

-Other Costs:
The 15 120 Euros declared for this reporting period is mainly coming from the dissemination actions (D1, website, conference, implementation actions...). A documentary of the I1 field campaign has been done in order to be used in the dissemination actions, especially for the participation in the JEP (explained in the technical part). However all other actions planned are conducted.

Breakdown of costs for Actions in Euro (excluding overhead costs)																						
		1. Personnel			2. TRAVEL				4. EQUIPEMENT			4.c Prototype			6. CONSUMABLES			7. Other cost					
	Short name of action	Budget Perso cost	Expensed perso cost 01/01/10-31/01/12	%	Budget Travel	Expensed travel 01/01/10-31/01/12	%	3. External assistance	Budget Equip	Expensed 01/01/10-31/01/12	%	Budget proto	Expensed 01/01/10-31/01/12	%	Budget conso	Expensed 01/01/10-31/01/12	%	Budget others	Expensed 01/01/10-31/01/12	%	TOTAL Budget	TOTAL Expensed	% budget
C1	Project Management by the coordinating beneficiary	65 837	41 899	64%	0	1 860		15 000				0			0						**80 837**	43 759	**54%**
C2	Monitoring the effctiveness of the actions (2010-2014)	157 722	74 577	47%	67 485	24 886	37%	0				0			0	384			609		**225 207**	100 456	**45%**
P1	Laboratroy testing of photocatalytical material	515 506	277 415	54%	2 440	2 143	88%	0	32 000	35 473,91	111%	0			104 100	33 532	32%				**654 046**	348 563	**53%**
P2	Tests under controlled atmospheric conditions	272 733	65 740	24%	4 800		0%	0				0			40 800	4 406	11%	51 000			**369 333**	70 146	**19%**
P3	Field studies scientific strategy and implementatio	89 705	58 619	65%	5 800			0				0			0						**95 505**	58 619	**61%**
P4	Instrumentation Quality Insurance	240 676	23 832	10%	11 440			0				0			22 700	422	2%	4 000			**278 816**	24 254	**9%**
I1	In situ monitoring campaign – 1	524 348	18 897	4%	56 230			0	43 000	2 043,99	5%	140 000			63 900		0%	6 000			**833 478**	20 941	**3%**
I2	In situ monitoring campaign – 2	472 591	177 900	38%	67 100	31 787	47%	0	3 100	1 280,21	41%	60 000	14 639	24%	84 040	34 782	41%	6 000	4 401	**73%**	**692 831**	264 789	**38%**
I3	Numerical modelling campaign and data analysis	278 450	113 958	41%	0			0				0			0						**278 450**	113 958	**41%**
D1	Website	32 344	12 512	39%	0			0				0			5 000	9 995	200%		1 000		**37 344**	23 507	**63%**
D2	Reporting	50 928	5 076	10%	0			0				0			14 000		0%				**64 928**	5 076	**8%**
D3	International dissemination of results	85 569	14 259	17%	4 800	3 932	82%	0				0			0	901		60 500	9 111	**15%**	**150 869**	28 203	**19%**
	TOTAL	**2 786 409**	**884 684**	**32%**	**220 095**	**64 607,6**	**29%**	**15 000**	**78 100**	**38 798**	**50%**	**200 000**	**14 639**		**334 540**	**84 422**	**25%**	**127500**	**15120**	**12%**	**3 761 644**	**1 102 271**	

Foreseen costs for Actions in Euro (excluding overhead costs)																
		1. Personnel		2. TRAVEL		3. Ext asst		4. Equipment		4.c Prototype		6.		7. Other cost		
	Short name of action	Budget Perso cost	Foreseen costs	Budget Travel	Foreseen costs	3. External assistance	Foreseen costs	Budget Equip	Foreseen costs	Budget proto	Foreseen costs	Budget conso	Foreseen costs	Budget others	Foreseen costs	TOTAL Foreseen costs
C1	Project Management by the coordinating beneficiary	65 837	23 938	0	-1 860	15 000	15 000		0	0	0	0	0		0	37 078
C2	Monitoring the effctiveness of the actions (2010-2014)	157 722	83 145	67 485	42 599	0			0	0	0	0	-384		-609	124 751
P1	Laboratroy testing of photocatalytical material	515 506	238 091	2 440	297	0		32 000	-3 474	0	0	104 100	70 568		0	305 483
P2	Tests under controlled atmospheric conditions	272 733	206 993	4 800	4 800	0			0	0	0	40 800	36 394	51 000	51 000	299 187
P3	Field studies scientific strategy and implementatio	89 705	31 086	5 800	5 800	0			0	0	0	0	0		0	36 886
P4	Instrumentation Quality Insurance	240 676	216 844	11 440	11 440	0			0	0	0	22 700	22 278	4 000	4 000	254 562
I1	In situ monitoring campaign – 1	524 348	505 451	56 230	56 230	0		43 000	40 956	140 000	140 000	63 900	63 900	6 000	6 000	812 537
I2	In situ monitoring campaign – 2	472 591	294 691	67 100	35 313	0		3 100	1 820	60 000	45 361	84 040	49 258	6 000	1 599	428 042
I3	Numerical modelling campaign and data analysis	278 450	164 492	0	0	0			0	0	0	0	0		0	164 492
D1	Website	32 344	19 832	0	0	0			0	0	0	5 000	-4 995		-1 000	13 837
D2	Reporting	50 928	45 852	0	0	0			0	0	0	14 000	14 000		0	59 852
D3	International dissemination of results	85 569	71 310	4 800	868	0			0	0	0	0	-901	60 500	51 390	122 666
																0
	TOTAL	2 786 409 €	1 901 725 €	220 095 €	155 487 €	15 000 €	15 000 €	78 100 €	39 302 €	200 000 €	185 361 €	334 540 €	250 118 €	127 500 €	112 380 €	2 659 373 €

Comments on the expenses for the period 01/01/10 -31/01/12 and the foreseen cost per action:

-*Action C1 & C2*: Project Management by the coordinating beneficiary and monitoring the effectiveness of the actions (2010-2014). The cost incurred for these actions are mainly personnel cost and travel cost (management meeting, technical meetings...). The percentage of expenditure is 54% and 45% for the midterm period.

-*Action P1:* As explain in the technical part, the P1 actions will be extended. Thus more consumables are needed and personnel cost will be declared for the next 6 months in order to achieve the project's results. 54% of the budget planned has been reported. Thus PhotoPAQ won't face extra cost for the extension of this action.

-*Action P2:* ICARE as action leader and all associated beneficiaries did not reported all their expenses about the use of the atmospheric chambers and more experiments are required for the project. Therefore, that why only 11% of the planned budget is expensed for this action.

- *Action P4:* In order to guarantee the success of this action and of the two next implementation actions, consumables are needed. That why only 2% of the planned budget is expensed for this action.

- *Action I1 and I2:* All the costs incurred for the first "indoor" campaign have not all be reported (due to some invoicing issues). Thus the percentage of expenses is lower as expected. Moreover the remaining budget for the I1 and I2 will be necessary in order to conduct the second campaign in Brussels and the "outdoor campaign". The foreseen budget for the second campaign I2 is 80 000Euros and the foreseen budget for the I1 campaign is 200Keuros.

-*Dissemination actions (D1, D2, and D3)*: During this period, the website has been implemented (the cost incurred was higher than planned), the brochures have been done, one international conference has been conducted….. The action for the next period are the organization of 2 international symposium, one in Corsica in May 2012 and one in Lyon in 2013. There is no extra cost forecast.

7. Annexes

Appendix 1 Minutes of the meetings

Appendix 1.1 : First Managment meeting
Appendix 1.2 : Second Managment meeting
Appendix 1.3 : Third Managment meeting
Appendix 1.4 : Fourth Managment meeting

Appendix 2 Job description EPM

Appendix 3 PhotoPAQ Consortium agreement

Appendix 4 Monitoring templates

Appendix 5 Press announcement

Appendix 6 Press release

Appendix 7 Picture of the notice board during I2 and T-shirts/ Brochures

Appendix 8 Intranet PhotoPAQ procedures

Appendix 9 Deliverables

Appendix 9.1: Delivrables (i), (ii), (iii)
Appendix 9.2: Delivrables (iv)
Appendix 9.3: Delivrables (v)
Appendix 9.4: Delivrables (vi)
Appendix 9.5: Delivrables (vii)

Appendix 10 Newsletters

Appendix 10.1: Newsletter 01
Appendix 10.2: Newsletter 02

Appendix 11 JEP

Appendix 11.1: Webpage/ Sponsor
Appendix 11.2: Picture 1
Appendix 11.2: Picture 2
Appendix 11.2: Picture 3

Appendix 12 Colloques

Appendix 12.1: Carrefour de la recherché_LISA
Appendix 12.2: Guangzhou worshop
Appendix 12.3: Nano round table
Appendix 12.4: 14th conference on Harmonization within Atmospheric Dispersion Modeling for Regulatory Purposes

Appendix 13 Notes and documents I2 campaign

Appendix13.1:Notebook_BrusselCampaign
Appendix13.2: Tunnel Leopold II scheme
Appendix13.3: Campaign meeting Conclusion de la réunion 15.07.11
Appendix13.4: Léopold II Ventilation
Appendix13.5: Planning Execution (PHOTOPAQ)_2011_v02-1
Appendix13.6:PhotoPaq_meetingCTG-CCB-BRRC _minutes_151110
Appendix13.7 :PhotoPAQ_P3 - Informal report on Brussel campaign Preparation - june 2011
Appendix13.8 : Projet PHOTOPAQ - Procès-verbal de la réunion du 15-07-2011

Appendix 14 LIFE+ Outputs Indicators