The Feasibility Study of H24 Bilateral Offset Credit Mechanism: Improvement of Vehicle/ Fuel Efficiency through the Introduction of Eco Drive Management System (EMS) for Taxi Operators, Viet Nam

(Undertaken by ALMEC Corporation)

Cooperating Agencies and Organizations	Ministry of Transport, Viet Nam Hanoi Taxi Group Institute of Planning and Transport Engineering, Viet Nam Energy Conservation Centre, Japan Ishida R&D, Ltd.
Host Country and Region	Hanoi City, Viet Nam
Sector of Technology	Transportation
Outline of Project Activities	The proposed program of activities targets the taxi operators in Hanoi which have been rapidly increasing apace with accelerating urbanization and motorization in the absence of adequate public transport means. The promotion of eco drive activities aims to reduce fuel consumption and thereby improve profitability of taxi operation, while contributing to a reduction of GHG emissions by the taxi fleet. The project site is Hanoi Taxi, Inc., the leading member of the Hanoi Taxi Group which is known to provide services of highest quality in the city.
Project Eligibility for Applying MRV Methodologies	1) MRV methodology development is applicable to the proposed transport-sector program of multiple activities in which the taxi operation with distance-based fare system would be improved in fuel efficiency with its GHG emissions reduced thereby. 2) MRV methodologies are applicable to internal-combustion engine vehicles (gasoline, diesel, gaseous fuels and biofuels), electric and hybrid cars. 3) The database of operated vehicle distance, vehicle occupancy rate and fuel consumption are well managed and available for analytical and monitoring purposes, or will be made available for such purposes. 4) The activities proposed for improving vehicle/fuel efficiency or transport efficiency are currently practiced by less than 5% of the total fleet of four-wheel taxis in the host city. 5) The proposed program of activities expects to utilize the technical, manpower and financial supports from Japan.
Reference Scenario and Project Boundary	● Project Boundary ・ The geographical boundary is the space encompassed by the administrative boundary in which the target taxi fleet is operated, namely Hanoi City. ・ The physical boundary is the taxi fleet which will participate in the program of activities proposed for improving vehicle/fuel efficiency and transport efficiency. ・ Emission calculation focuses on CO_2. If gaseous fuels are used, CH_4 will be included. ● Reference Scenario ・ The reference scenario is the continuance of the present taxi operation (vehicle type, fuel type, driving skills, dispatch method, fuel efficiency)

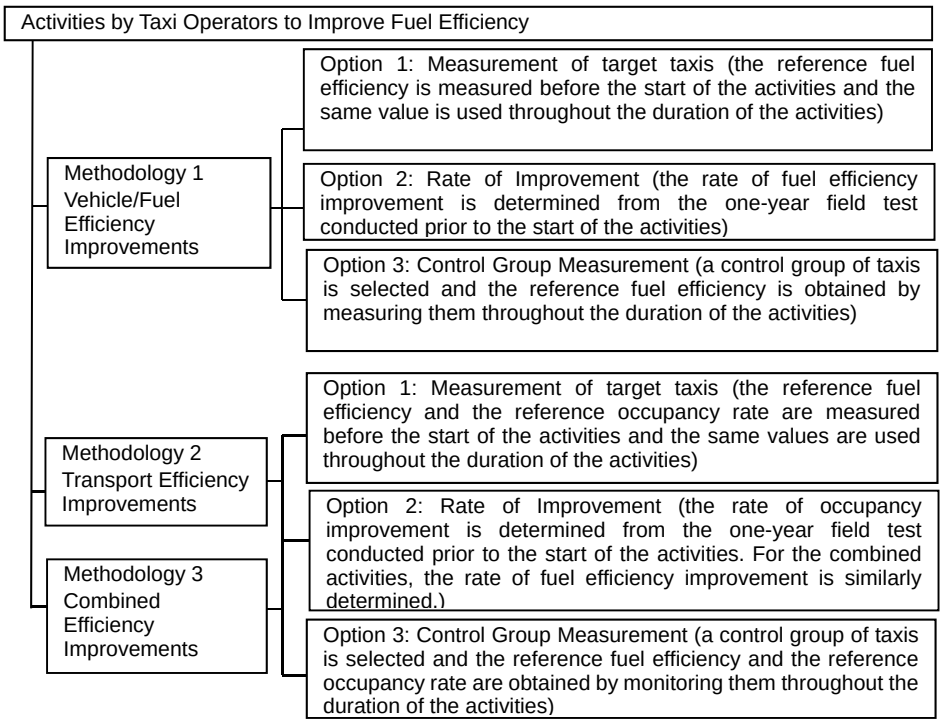
- In many large cities of developing countries, the transport demand has been increasing apace with growing population and income and shifting from walk and bicycle to motor bike and automobile. As a result, the increased road traffic is intensifying inner city congestion and raising the fuel consumption per kilometer of travel. The volume of GHG emissions per vehicle kilometer keeps rising in urbanized areas. In Hanoi City where there is yet no mass transit as of 2013, CO_2 emissions per vehicle kilometer is on the rise and the trend is expected to continue through 2020, the year when the proposed project activities are scheduled to end.

Forecast of Operational Speed in the Road Network of Hanoi (km/h)

2005 (actual)	2020 Forecast (BaU)	2020 Forecast (HAIDEP NW: Mass Transit Development)	
		Mass Transit Only	Mass Transit & Traffic Demand Management
26.0	9.4	22.0	35.2

Source: Study Report on The Comprehensive Urban Development Programme in Hanoi Capital City, Vietnam (HAIDP), JICA, March 2007.

Methodology Options



Formula for calculating the emission reductions by the activities proposed for improving vehicle/fuel efficiency.

$$ER_{VE,y} = \sum DD_{i,y} \times \left(RFC_{i(x)} - PFC_{i(x),y}\right) \times NCV_x \times EF_{CO2,x}$$

Option 1 Measurement of Target Taxis	The reference efficiency is measured before the start of project activities and is held constant throughout the project period. $RFC_{i(x)} = Constant$
Option 2 Rate of Improvement	The rate of improvement $P_{VE,i(x)}$ is determined on the basis of the field test conducted for one year before the start of project activities. $RFC_{i(x)} = PFC_{i(x),y} / \left(1 - P_{VE,i(x)}\right)$

	Option 3 Measurement of a Control Group of Taxis: A control group of taxis is designated and the reference efficiency $\boldsymbol{RFC_{i(x)}}$ is obtained by regularly monitoring them throughout the project period.
Default Parameters	There are three alternatives to establish the default value for Option 2 of Methodology 1 1) A one-year field test is conducted prior to the start of project activities and the rate of improvement is determined from the monitored results. 2) The target taxi fleet is monitored before the start of project activities exactly like Option 1 of Methodology 1 to obtain the reference fuel efficiency. During the first year of project implementation, the target taxi fleet is monitored again to establish the rate of improvement vis-a-vis the reference efficiency. 3) The rate of improvement is determined by comparing the fuel efficiency of with-project vehicles and the reference vehicles with the efficiency quoted in the catalogues of vehicle manufacturers.
Monitoring Method and Procedure	Key parameters to be monitored and the procedure of monitoring are as follows

Parameter	Monitoring Method and Procedure	Frequency
$DD_{i,y}$: Vehicle Operated Distance (km)	1) The data are collected from the monthly operational reports of taxi companies, or 2) Monthly operated distance is outputted to the spreadsheet from the logs of odometers	Monthly
$PFC_{i,x,y}$: With-Project Fuel Efficiency (L/km)	1) The basic data for fuel consumption are collected from monthly operational reports of taxi companies, or 2) The fuel consumption is ascertained by checking the invoices of suppliers, and the operated kilometers are obtained by reading the logs of GPS and odometers	Monthly

GHG Emissions and Reductions

Parameter	Parameter Calculation or Parameter Source	Output
$DD_{i,y}$: Annual total operated kilometers	Target fleet of 2,100 taxis Annual total operated distance of 55,073 km/vehicle	115,653,300 km
$PFC_{i,x,y}$: With-Project fuel consumption per km	Estimated from the monitored performances (fuel consumption and rates of improvement in fuel efficiency) by participants in the eco drive training program over the period of 7 months	0.0712 L/km
$NCV_{x,y}$:Net calorie emission	IPCC default (averaged)	32.81 GJ/kl
$EFCO_{2,x,y}$: CO_2 Emission Factor	IPCC default (averaged)	0.0693 tCO2/GJ
P_{ve}: Rate of improvement in fuel efficiency	Average of the performances by the participants in the eco drive training program	5.1 %
PE: With-Project Emissions	Obtained by calculation	18,721 tCO2/y
RE: Reference Emissions	Obtained by calculation	19,727 tCO2/y
ER: Emission Reductions	Obtained by calculation	1,006 tCO2/y

Third Party Verification	・Initial Verification ascertains 1) whether the project activities are being put into practice as programmed, 2) whether the monitoring system is properly established and capable of performing its functions, and 3) whether the project activities are likely to achieve the expected emission reductions. ・Regular verification is carried out annually to check 1) whether the operative monitoring system and procedure conform to the stipulations in the initially worked out monitoring plan, 2) whether the reported emission reductions contain serious errors or omissions, and 3) whether the reported GHG emission reductions are sufficiently proven by the monitored records and other factual evidences.
Environmental Impact	The proposed program of activities is not expected to cause any serious environmental hazards and other adverse influences.
Financial Planning	The proposed activities will be financially self-sustainable during the project period, except for the initial investment in equipment and the startup operational cost. Considering the participation of many taxi companies, a two-step program loan would be needed from the global environmental conservation facility (GREEN) of the JBIC fund. The credit expected to be certified on the emission reductions will not be very large. However, the effect of energy conservation (saving on fuel consumption) is considerable, enabling the taxi operators to save some ¥40 million annually. The EMS Center, the provisional operational entity of the project activities, would be sustainable by charging the taxi companies the commissions worth 30% of their energy savings. If the project scope be expanded in the future to include other vehicles, the Center would be able to earn some profits.
Introduction of Japanese Technology	In addition to the introduction and promotion of eco drive practices, there are many other technologies and expertise in Japan which will be effectively put to use for the purpose of improving vehicle/fuel efficiency in the taxi business: namely, a taxi dispatch system, ICT ticketing and above all, hybrid cars and other low-carbon vehicles. Hybrid cars merit special consideration because their introduction will greatly increase the saving on fuel consumption and raise the level of fuel efficiency. When accepted by a wider range of automobile users, possible emission reductions would be quite large.
Contribution to Sustainable Development in the Host Country	In the National Strategy for Climate Change in Viet Nam, the policy stance regarding GHG emission reductions emphasizes the importance of the transport sector. It stipulates that emission reductions will be realized by promoting increased consumption of low-carbon fuels. Specifically, the shift of buses and taxis to compressed and liquefied natural gas is to be accelerated so that such fuels would reach 20% by 2020 and 80% by 2050 of their total consumption. When the anticipated fuel shift is combined with eco drive activities like those suggested by the present Study, the expected saving on energy consumption would become considerable. The MRV methodologies developed by the Study are applicable to such a combination of multiple activities. In addition to electric and hybrid cars, Japan has an array of technologies usefully applied to Viet Nam. For example, the existing vehicles with gasoline or diesel engines will be easily fitted up with the available kits of fuel conversion to CNG or LNG. The MRV methodologies developed by the Study can be applied to any situation that would combine eco drive activities and the introduction of low-carbon vehicles to reduce GHG emissions. Assured of the accelerating emission reductions as verified by the MRV methodologies, the transport sector is expected to contribute in no uncertain terms to the sustainable development of the host country.

A FEASIBILITY STUDY OF THE BILATERAL OFFSET CREDIT MECHANISM (JCM): Improvement of Vehicle/Fuel Efficiency through the Introduction of an Eco-Drive Management System (EMS) in Viet Nam

ALMEC Corporation

1. Implementation of the Study

Table 1 Study Implementation

Participants	Role in the Project Implementation
Energy Conservation Center, Japan	Sending qualified instructors for the eco drive training program to be managed by Hanoi Taxi Group
Ishida R&D, ltd.	Supplying the EMS software, including translation into Vietnamese and other additional modifications of the application. Testing the behaviors of the application and providing training on its operation.
Hanoi Taxi Group (HTG)	As the designated project site, HTG collaborates with the feasibility study team by making the taxi fleet available for monitoring relevant MRV parameters and verifying the behaviors of the proposed EMS apparatuses during the field test. It assigns drivers to participate in the eco drive training courses and makes monthly operational reports and other types of business documentation available for the development of MRV methodologies.
Institute of Planning and Transportation Engineering (IPTE)	Coordinating project implementation, by managing monitored EMS data and searching relevant data and information for compilation and analysis.
University of Transport Technology UTT)	The University is affiliated with the Ministry of Transport and currently implementing a pilot eco drive project. The institution is thus well placed to supply the factual information on the current eco drive practices in Viet Nam and cooperate in the eco drive training courses proposed by the Study for monitoring.

2. Outline of the Program Components and Activities

(1) Program Components and Activities

Table 2 Program Components and Activities

	Remarks
Host Country	Viet Nam
Program Area	Hanoi City
Program Target and Scale	Fuel Efficiency Improvements of a fleet of 2,100 taxis
Applied Technical Components	Degitaco application for smart phones and fuel efficiency management methods
Prospective Counterpart for Program Implementation	Hanoi Taxi Group (HTG)
Prospective Operational Entity of the Program Activities	EMS Center (provisional)
Program Outline	Reducing fossil fuel consumption by raising the level of fuel efficiency, and thereby contributing to the reduction of greenhouse gas emissions

(2) Current Situation in the Host Country

The investment environment for transport operators in Viet Nam has been adversely affected by the general economic recession and the deteriorating financing activities in recent years.

The so-called "software" approach that requires no large initial capital outlay has been increasing its importance in addressing various transport issues. Transport operators are trying to reduce costs and improve the profitability of their operation, whereas the public sector in charge of roads and other transport infrastructure management is beginning to put more stress on traffic demand management such as signal controls and entry restrictions in order to alleviate the problem of traffic congestion. The proposed program of eco drive activities will suitably fit the changing circumstances in Viet Nam. Its technical requirements are applicable to all types of fossil fuel automobiles and promise favorable cost performances, including immediate effects of energy saving and GHG emission reduction suitable to Viet Nam.

Since the cabinet reshuffling in August 2011, the newly appointed Transport Minister has announced a succession of policies addressing such issues as the national transport system development and the measures to control traffic congestion in the cities of Hanoi and Ho Chi Minh.

Three priority areas are stated as 1) development of transport infrastructure, 2) traffic safety measures and 3) alleviation of traffic congestion. Regarding infrastructure, the construction of the north-south arterial, the upgrading of the existing railways and the development of regional road networks are judged high in priority. Traffic safety measures are considered most urgent in Hanoi and Ho Chi Minh where the problem of traffic congestion has been intensifying. More specifically, it is proposed to develop and strengthen the public transport means in these cities. In October 2011, for example, a Minister of Transport directive was issued encouraging the use of buses by transport-related public sector employees in the said cities.

The policy tools concerning climate change have been variously formulated in Viet Nam according to the National Strategy on Climate Change, proclaimed on December 5, 2011. The Strategy identifies a number of priority issues to be coped with during the period of 2011 – 2015. Regarding the transport sector, the increased use of energy-saving transport means and the step-by-step replacement of fuel guzzling vehicles are prioritized in the agenda. In the 2nd National Communication to UNFCCC, the government indicated 1) the conversion from diesel to compressed natural gas in motorized traffic and 2) the use of LPG by taxi.

(3) Complementarity of JCM to CDM in Project Application and Approval

① Additionality

The proposed activities for Viet Nam promise a high energy saving performance in financial analysis. However, it is not very easy to carry out its CDM-required investment analysis by means of the expected carbon credit on GHG emission reductions, because the program does not involve any sizable investment of capital. Consequently, the additionality would have to be demonstrated by the analysis of either technology, common practice or some other type of barriers, but this option has been proven difficult, if not impossible, in the CDM application process. In contrast, the JCM/JCM-sponsored methodologies, now being variously developed for verification and approval, are to stress the eligibility of a proposed project activity rather than the CDM-defined additionality. The involvement of some Japanese technology in a proposed project activity implies that the said technology is not available in a given host country, demonstrating the additionality of a sort in the said country. By the similar logic, Japan's financing of the said project activity suggests another aspect of additionality to the host country. To put it differently, the Bilateral Offset Credit Mechanism (JCM) does not need explicit and detained analysis and demonstration of additionality as required for CDM project proposals. An energy-saving project activity, as exemplified in the present program for taxi operators in Hanoi, could be approved by JCM without rigorous demonstration of its financial additionality.

② Emission Reducing Activities by Behavioral Change

The CDM protocol is not likely to approve a project activity which can be achieved primarily through behavioral changes and involves no sizable investment in physical facilities and equipment. Project activities that propose to transform behavioral patterns

would be added, as it is hoped, to the JCM agenda for approval, as long as the proposals reasonably meet such methodological requirements as valid boundary definition, monitoring system design, methodology development for demonstrating additionality and so forth.

③ Comprehensive MRV Methodology Development for Multiple Activities

Methodological development is essential to deal with those projects that involve a variety of emission reducing actions that are not accompanied by sizable investment in infrastructure. If a program for fuel efficiency improvement is to be proposed for the taxi operation, like the present case in Viet Nam, it would include some eco drive training courses for taxi drivers, increased use of low-carbon fuels and energy-saving vehicles, optimization of the taxi dispatch system, reduction of time taxied without passengers and other myriad actions. Evidently, there is yet no CDM-approved methodology capable of dealing with all of these multiple activities at one stroke. Admittedly, it will be difficult to develop a methodology or methodologies applicable to a program of multiple activities, because such development is likely to run counter to the rigorous and conservative protocol for CDM approval. MRV methodologies for the proposed program in Viet Nam must be comprehensive and flexibly applicable to multiple activities and the present Study considers that the practicability is the key aim of methodology development.

④ Sustainable and Comprehensive Emission Reducing Activities

The improvement of fuel efficiency is achievable only when energy saving activities are sustained continuously from year to year. It is quite possible that the program boundary might be expanded or new activities might be added when the program is proven successful. Multiple activities could be analyzed in the CDM framework by bundling them as a Program of Activities (PoA). CDM procedures for PoA application are too restrictively rigorous for a change in the initially approved program boundary such as an addition of a new component activity (CPA) and some modification of the initial CPAs. The issue is easily corroborated by the plain fact that there has been only one CDM-approved PoA in the transport sector. Presumably, the procedural complexity of identifying and sustaining CPAs for a given PoA discourages an attempt to apply a transport PoA for CDM approval. Essentially, emission reducing activities of the transport sector need be sustained over time. Given the restrictive CDM/PoA procedures, JCM/JCM needs to provide more accessible protocols and procedures of application and approval.

3. Content of the Study

(1) Issues to be Studied

【Initially Identified Issues for the Feasibility Study】

① The present situation of taxi operation in Hanoi: it is necessary to ascertain whether the relevant data for calculating emission reductions is obtainable from the target taxi operators.

② The effect of the eco drive activities on fuel efficiency: the most important task of the Study is to measure the fuel/vehicle efficiency improvements achievable through the eco drive activities.

③ Practicability of using the smartphone application for eco-drive management (guidance and monitoring): it is necessary to ascertain whether the smartphone application pre-selected by the Feasibility Study is practicable for the taxi fleet in Hanoi.

④ MRV methodology development (multiple applicability): it is necessary to develop a MRV methodology or methodologies which can handle a bundle of multiple activities which would together contribute to the improvement of vehicle/fuel efficiency.

⑤ MRV methodology development (options of reference emissions): For the purpose of calculating emission reductions achievable through improved fuel efficiency, it is necessary to take into account those factors which do not directly concern taxi operators

but variously influence the level of emissions used as baseline reference. Namely, the present conditions of transport infrastructure and the traffic demand of other modes cause congestion and accordingly influence the level of emissions by the taxi fleet. In addition to weighing the significance of such factors for methodology development regarding the reference emissions estimation, it is considered equally necessary to devise a simplified format or formats for estimating emissions and reductions thereof.

⑥ Selection of an operational entity for the program: the Hanoi taxi operators are the host party to the proposed activities and yet they would not make a suitable operational entity for the program. Their primary interest would be more or less satisfied if they get the tangible benefit of reduced fuel consumption and their interest in emission reduction is motivationally very limited. Therefore, it is necessary to examine possibilities of practicable institutional development and thereby formulate a scheme with an appropriate operational entity which would suit the JCM/JCM framework.

【Issues Found after the Start of the Study 】

⑦ Security of the OBDII data logger: it is found necessary to examine the possibility that the data logger of OBDII (On-board Diagnostic Application) might adversely affect the vehicle security via the Controller Area Network (CAN).

⑧ Future prospects of fuel efficiency improvements by taxi operators: on the basis of the FS findings on the issues mentioned above, it is necessary to examine the future sustainability and direction of project activities performed by the taxi operators

(2) Content of the Study

① Field Survey

The Study was conducted during the period from July 2012 to January 2013. The details of the itinerary and the findings are shown in the Appendix.

② Eco Drive Training

The eco drive lectures and field training were carried out in September 2012. The training program aimed to impart the technical mastery of eco drive practices to the participants. The monitored improvement of fuel efficiency averaged 6% in the suburban course and 2% in the inner city course. The details of the training activities are shown in the Appendix.

③ Data Logging of Taxi Operation

The proposed EMS system can log 55 types of data, including date and time of the day, GPS coordinates (latitude and longitude), operating speed and fuel efficiency. The logged data are used to analyze the attributes of taxi operation per day of the week and per time zone of the day. The details of the logged data are shown in the Appendix.

④ Summary of FS Findings

Table 3 Summary of FS Findings

Study Issue	Summary of Findings
① Present Conditions of Taxi Operation in Hanoi and Availability of Relevant Data	It was found that monthly operated distance and fuel consumption were logged per vehicle and aggregated by target taxi companies. However, company managers were generally reluctant to provide these basic data, including taxi occupancy rates, which would be vital for business management. They were of the opinion that fuel consumption reports by the drivers were often unreliable. The possibility of obtaining relevant data from the EMS apparatus was then discussed, but quickly judged impractical because of the technical hazards of opening the application for data retrieval and then making the data adjustments for use. The present custom was that drivers would

	purchase fuels out of their pockets. As one of the steps toward business modernization, it was proposed that the companies would pay the fuel cost so that the Study Team could use the data in their monthly operation reports.
② Field Trial of Fuel Efficiency Improvement by Eco Drive Taxi Operation	In order to estimate the effect of eco drive activities on fuel efficiency improvement, field tests were carried out to measure and compare the efficiency before and after the eco drive introduction. The trial on the congestion-free suburban course yielded the average improvement of 6%, while the test on the congested inner city course returned the average of 2%. The aggregated average of 5% improvement in fuel efficiency was disappointingly low. A few reasons can be listed. The fuel in Viet Nam is rather expensive relative to average household income. Because taxi drivers pay the fuel cost, they commonly practice energy-saving driving. Traffic signals are few and far between, and therefore there is no significant fuel-saving merit in such eco drive practices as reduction of idling time and slow stepping on the accelerator. In other words, the diffusion of eco drive activities as practiced in Japan will not be sufficient to improve fuel efficiency of taxi operation in Hanoi.
③Practicability of Eco Drive Management (Technical Training & Monitoring) by the Smartphone Application	The eco drive guidance and monitoring by the smartphone application turned out to be a somewhat trying experience. Going through with the procedure of switching on the smartphone, selecting the application from the menu, clicking on the monitoring command, clicking on the eco drive guidance function, retrieving data from the log and so forth turned out to be troublesome and time consuming. Consequently, it was decided that eco drive guidance would be given during the training program for drivers and the monthly class for company managers which reviews the monthly reports. Monitoring was also done on the monthly data logs. It might be possible to use some digital tachograph apparatus, but the present Study is not required to pursue this possibility (possible but not obligatory).
④ MRV Methodology Development (Multiple Applicability)	Based on the UNFCCC-proposed Guidelines for Standardized Baseline for the Transport Sector (July 2012, UNFCCC Secretariat), the Study developed JCM/JCM methodologies applicable to a bundle of investment and emission reducing activities by taxi operators. The methodologies eliminate the emission reducing effects from the infrastructure development, and investments and efficiency improvement activities by other automobile users.
⑤Methodology Development (Reference Emissions)	How to set the reference emissions is a crucial question in MRV methodology development. The Study proposed two methodologies for calculating the reference emissions. One is to obtain the reference emissions by monitoring and measuring the actual fuel efficiency during taxi operation. The other is to set the rate of improvement on the basis of the monitored efficiency data and iterate the calculation of the reference emissions throughout the project period.
⑥Operational Entity	The taxi operators in Hanoi will continue their activities for fuel efficiency improvements and in due course expand and diversify their efforts in cooperation with Japan. For this purpose, the Study deemed it necessary to design a scheme and identify an entity which operates and manages the scheme. As it became clear during the FS implementation, the program of activities for taxi operators is only the beginning. Ultimately, vehicle/fuel efficiency improvements must be spread to all motorized vehicles using fossil fuels. This calls for various policy instruments to lighten the financial burden on automobile users, such as tax benefits and soft loans for purchasers of low-carbon vehicles. With this wider

	perspective in mind, the Study proposed the establishment of a scheme with its own operational entity. The scheme will prove to be an effective JCM/JCM-sponsored program.
⑦ Security of OBDII Data Logger	For the purpose of monitoring, smartphones must be connected via the Bluetooth apparatus to the On-board Diagnostics II (OBDII). If the application should run berserk for some reason or another, it could transmit total gibberish to the Controller Area Network (CAN). The security risk of causing such a bomb cannot be absolutely denied. Even though the probability is presumably very slight, it must be acknowledged that automobile manufacturers are inimical to the idea of installing apparatuses other than those of their own make to their automobiles. Accordingly, the Study concluded that the proposed project activities would not include the retrieval of CAN data by the OBDII data logger.
⑧ Future Direction of Fuel Efficiency Improvement for Taxi Operators	For the vehicle/fuel efficiency improvements among the taxi operators in Hanoi, a highly effective measure is to introduce low-carbon vehicles at the time of fleet expansion or vehicle replacement. The Study assessed this future prospect by comparing hybrid cars, LPG vehicles, CNG vehicles and other low-carbon vehicles and concluded that hybrid cars would be the most feasible choice among them.

4. Study Results of the Proposed Activities for Bilateral Offset Credit Mechanism (JCM)

(1) Emission Reductions by the Proposed Activities

【Rationale of the Proposed Activities in Reducing GHG Emissions】

The presentation below is prepared in accordance with the *Guidelines for Standardized Baselines for the Transport Sector* (v1.0) (July 2012, Grutter Consulting AG).

① Activities to Improve Vehicle/fuel Efficiency

Activities are proposed to raise the vehicle/fuel efficiency and thereby reduce carbon emissions per unit of travel distance. They include the use of low-carbon fuels, improvements to the existing vehicles and driver education and training, which would not entail drastic changes in vehicle size, occupancy rate and/or method of vehicle use. The parameter is the volume of emissions per unit of travel distance (km). The reference scenario represents the case where the operation of the same comparable mode or vehicle type would continue as before without improvement activities.

② Activities to Improve Transport Efficiency

Activities are proposed to improve the occupancy rate of taxi operation and thereby reduce the emissions. They include better managed dispatch system, development of taxi stands and other measures to improve the convenience of public transportation. The parameter is the volume of emissions per unit of occupied travel distance (km). The parameter of passenger kilometer is not suitable for the business of taxi operation for hire. The target for emission reduction is better measured by the parameter of occupied vehicle kilometer. The improvement of transport efficiency is different from the investment in some new low-carbon mode (e.g. modal shift), because it is achieved by using the same mode or vehicle type more efficiently. The reference scenario represents the case where the operation of the same comparable mode or vehicle type would continue as before without improvement activities.

③ Combined Measures

Interventions may include vehicle efficiency plus transit efficiency measures e.g. vehicle efficiency plus improved vehicle dispatch measures. In combined cases always the indicator paid mileage km shall be taken as transit efficiency will always reflect changes

in both types of efficiency.

【Content of MRV Methodology Development for Measuring Emission Reductions】

① Systemic Consolidation of MRV Methodologies for the Transport Sector

The Study was required to develop methodologies for efficiency improvements in the transport sector. As mentioned above, the efficiency improvements are divided into two categories: namely, (i) those for vehicle/fuel efficiency and (ii) those for transport efficiency. The methodological development addressed each category and the two categories combined. The methodological development was tailored for the taxi operation in Viet Nam, but its systemic model building will ensure the easy applicability to other modes such as bus, freight vehicle, privately owned automobile and so on with due modifications. The applicability will extend to other countries as well.

② Key Elements of MRV Methodology Development for Vehicle/Fuel Efficiency Improvement Activities

1) Appropriate sample size necessary for setting the reference fuel consumption per kilometer

2) Setting the reference fuel consumption on the basis of the fuel efficiency quoted in auto-makers' catalogues

3) Setting the reference emissions by monitoring a control group of taxis

4) Small-scale CDM projects with annual emission reductions of 60,000 CO_2 tons or less are exempted from leakage calculation. Therefore, the leakage emissions of the proposed activities are not included in methodology development.

5) The Study examined the possible need of updating the reference emission factor (fuel efficiency) during project implementation and concluded that the value set at the start of the project activities be applied throughout.

6) Regarding the net calorie emission and the emission factor, the Study followed suit of the practice in AMS-III.BC, the latest CDM-approved methodology for similar projects, namely, used national values indicated in the latest version of IPCC assessment as defaults.

③ Key Elements of MRV Methodology Development for Transport Efficiency Improvement Activities

The foremost business requirement of taxi operation is to increase occupied vehicle distance and raise sales. By the similar logic, a decrease of unoccupied vehicle distance means a reduction of the operational cost. Supposing the occupancy rate of 40% and the occupied vehicle distance of 100km, the total operated distance would come to of 250km with fuel consumption of 25 liters per km. If the occupancy rate be raised to 50% by the introduction of a better dispatch system and the provision of taxi stands, the total operated distance would drop to 200km with fuel consumption reduced to 20 liters. This means that emissions could be reduced by 20%. The fuel efficiency per kilometer of occupied distance would improve from 0.25 to 0.2 liters/km.

④ Key Elements of MRV Methodology Development for Combined Measures Activities

Measurement method for combined measures activities are equivalent to that of transport efficiency improvement activities. Formulation of option 2 is added.

(2) Project Eligibility for Applying MRV Methodologies

The eligible conditions of the proposed activities for applying MRV methodologies are as follows.

① MRV methodological development is applicable to the proposed transport-sector program of multiple activities in which the taxi operation with distance-based fare is to be improved in fuel efficiency with resultant reductions of GHG emissions.

② MRV methodologies are applicable to internal-combustion engine vehicles (gasoline, diesel, gaseous fuels and biofuels), electric and hybrid cars.

③ The database on operated vehicle distance, vehicle occupancy rate and fuel consumption are well managed and available for analytical and monitoring purposes as required by MRV methodologies, or will be made available for such purposes.

④ The proposed program of activities expects to utilize technical, manpower and financial supports from Japan.

(3) Options for Methodology Development

The Study developed three options for calculating the effects of the proposed activities on emission reduction. Option 1 is applicable to vehicle/fuel efficiency improvements and Option 2 to transport efficiency improvements. Option 3 is applied to the combined bundle of these activities.

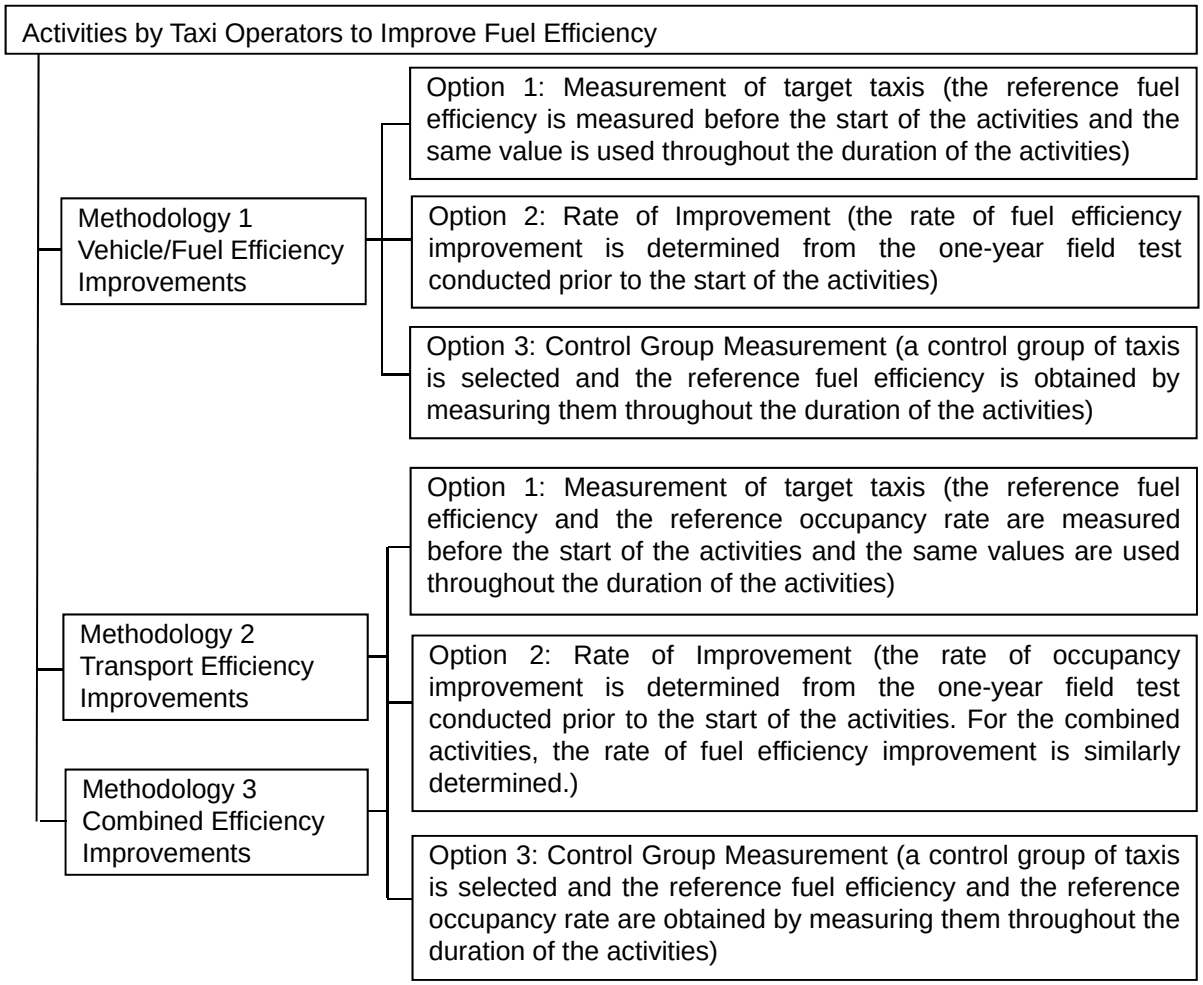
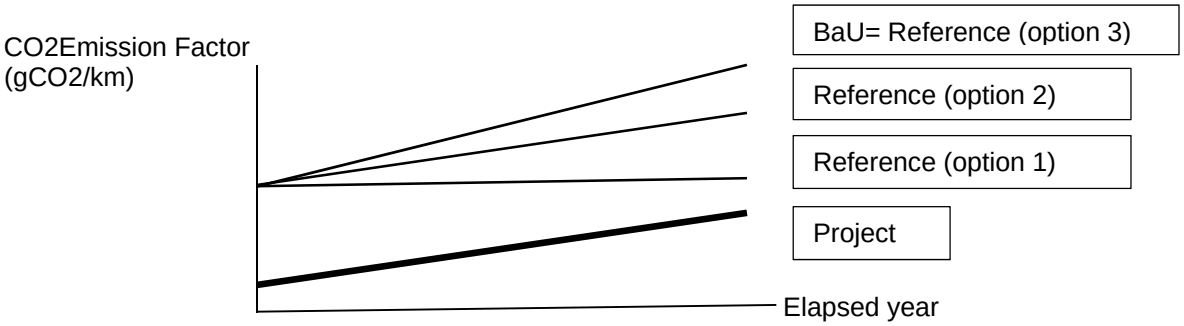


Figure 1 Options for Calculation

The applicability, to stay on the conservative side, of each of these calculating options varies depending on whether the baseline CO_2 emission factor per vehicle operated kilometer is set to increase, stay constant or decrease. If the factor is set to decrease, for example, Options 1 and 2 cannot be selected for application. The baseline emission factor is affected by such factors as vehicle attributes (catalogued fuel efficiency performance and vehicle size), types of fuels (CNG and biofuels), drivers' performance (eco drive skills), conditions of infrastructure (levels of road development and the presence of mass transits) and socio-economic conditions (income levels and business cycles). However, the operating speed is the most important influence on the emission factor. Therefore, it is necessary to check the available statistical data from the reliable sources. Regarding the taxi operation, it is possible to judge from the annual trend of taxi GPS logs.

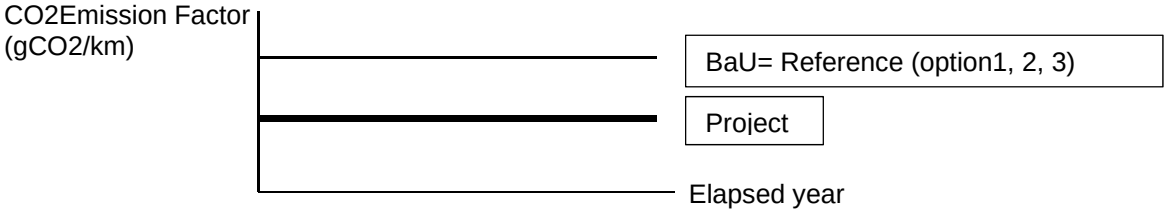
① Reference Scenario with the increasing CO_2 emission factor per operated km

Where the emission factor is set to increase, Option 3 yields the most accurate estimate of the reference emission factor. More simplified formats of Options 1 and 2 are usable for the estimation. When the monitoring cost does not differ much between the two options, Option 2 can provide an estimate of higher accuracy than the other.



② Reference Scenario with the constant CO_2 emission factor per operated km

Where the operating speed is improving, all three options can calculate the reference emission factor. Option 1 is the easiest to apply.



③ Reference Scenario with the decreasing CO_2 emission factor per operated km

Where the operating speed is improving, Options 1 and 2 are not applicable. Only Option 3 can yield the reference emission factor.

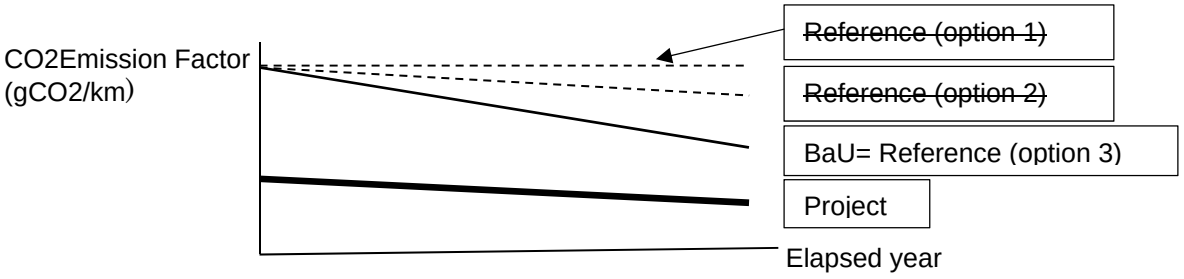


Table 4 Monitoring Targets for Estimating Reference Fuel Efficiency (Vehicle/Fuel Efficiency Improvements)

Target for Monitoring	Method for Estimating Reference Fuel Efficiency
Project Participating Vehicles (either the entire taxi fleet or samples)	1) The reference value is determined from the operational records during one to three years prior to the start of the project activities (Options 1 and 2)
	2) The reference efficiency is measured for one year after the start of the project activities and then low-carbon technology will be introduced (Options 1 and 2)
Control Group of Taxis	3) Measurement is iterated for one year after the start of the project activities or throughout the project duration (Options 1, 2 and 3)

(4) Necessary Parameters

The table below shows parameters needed to calculate GHG emissions by the respective options. It indicates whether to use the default values (D), to determine from the monitored results before the start of project activities (S), or to determine from the data regularly monitored after the start of project activities (M). The table also indicates the present availability of relevant information and data in Hanoi.

Table 5 Parameters Necessary for Calculating GHG Emissions and Applicable Methods and Options, with Present Data Availability

Parameter	Default (D), Project-specific (S) or Monitored (M)	Availability	Remark
NCV_x: Net Calorie Emission of Fuel (J/L)	Common to three methodologies D (Options 1, 2 and 3)	a) Data provided by fuel suppliers b) National values of Viet Nam c) IPCC Defaults	Monitored once before the start of project activities
$EF_{CO2,x}$: CO2Emission Factor (gCO2/J)			
$PFC_{i(x),y}$: With-Project Fuel Consumption (L/km)	Common to three methodologies M (Options 1, 2 and 3)	Monthly records of operated kilometers and fuel consumption are available for annual aggregation	Monitored once every month
$DD_{i,y}$: Operated Distance (km)			
$PMR_{i,y}$: Project Occupancy Rate (%)	Common to Methodologies 2 and 3 M (Options 1, 2 and 3)	Monthly records of occupied kilometers are available for calculating fare receipts	Monitored once before the start of project activities
$RFC_{i(x),y}$: Reference Fuel Consumption (L/km)	Common to three methodologies S (Options 1 and 2) M (Option 3)	a) Retrievable either from monthly records or by monitoring prior to the start of project, or by monthly monitoring of the control group b) Retrievable from the	(Options 1 & 2) Monitored once before the start of project activities (Option 3) Control group monitored every month after the

		invoices of fuel suppliers, GPS logs or odometer logs	start of project activities
$RMR_{i,y}$: Reference Occupancy Rate (%)	Common to Methodologies 2 and 3 S (Options 1 and 2) M (Option 3)	Retrievable either from monthly records or by monitoring prior to the start of project, or by monthly monitoring of the control group	
$P_{VE,}$: Rate of Fuel Efficiency Improvement	Common to three methodologies S (Options 1, 2 and 3)	To be determined by the field test over one year before the start of project activities	Monitored once before the start of project activities
P_{TE}: Rate of Occupancy Rate Improvement	Common to Methodologies 2 and 3 S (Options 1, 2 and 3)		

(5) Default Parameters

Among the listed information and data types indicated in Table 4, the default values are used for the following data.

Table 6 Default Values for Calculating GHG Emissions and their Sources

Parameter	Default and its Source
NCVx,y: Net Fuel Calorie (J/L)	National values (as reported by the government or some public authorities of the host country), or IPCC defaults: averaged 32.8GJ/KL
$EF_{CO2,x,y}$: CO_2 Emission Factor of Fuel (gCO_2/J)	National values (as reported by the government or some public authorities of the host country), or IPCC defaults: averaged 0.0693tCO_2/GJ

The reference values specific to the proposed activities, namely, the fuel efficiency and the rate of fuel efficiency improvement used on the activities for vehicle/fuel efficiency and the occupancy rate and the rate of improvement thereof needed for the activities for transport efficiency improvement, are determined by the procedures indicated in Table 7.

Table 7 Procedures for Setting Project-specific Values for Emissions Calculation

$RFC_{i,x,y}$: Reference Fuel Consumption (L/km)	
	The reference emission factor for Option 1 is determined from the reference fuel efficiency. The reference fuel efficiency is calculated by dividing the annual fuel consumption (FC) per mode or vehicle type regarding the entire fleet or samples thereof, covering preferably three years or at least one year prior to the start of project activities, by the similarly calculated annual operated distance (D) per mode or vehicle type. The obtained reference fuel efficiency is held constant throughout the project period. To keep the calculation on the conservative side, modes must be carefully differentiated by noting types of fuels used and catalogued rates of fuel consumption. The method of sampling follows the CDM rules. See "the latest version of the Standard for sampling and surveys for CDM project activities and program of activities." If the necessary records are not available or are available but cover less than a year, the reference fuel efficiency can be obtained by one of the following procedures.

	a) When the existing vehicles are targeted for the proposed activities and it is possible to identify the reference vehicles, or in other words when the same vehicle types are being operated under the same conditions in the host city, their past records of annual fuel consumption and annual operated distance, preferably covering three years or at least one year, can be used to calculate the reference fuel efficiency. b) When a new vehicle type is to be added as part of the proposed program, vehicles of the similar type in operation are sampled to calculate the fuel efficiency, covering their past records of three years or at least one year. The fuel efficiency of the upper 20 percentile of the samples is then used as the reference value. For Option 2, a field test is conducted over one year for monitoring the fuel efficiency performance to determine the reference rate of improvement. The obtained reference rate is held constant throughout the project period. For Option 3, a control group of vehicles is selected and regularly monitored during the project period to obtain the reference fuel efficiency.
p_{VE} : Rate of Fuel Efficiency Improvement (activities for vehicle/fuel efficiency improvement) (%) Note: For the definition of p_{VE}, see the description of Option 2 in Methodology 9.1.	The procedures indicated above regarding the reference fuel efficiency are similarly applied to the calculation of the reference rate of improvement for fuel efficiency, the reference occupancy rate and the reference rate of improvement for occupancy rate.
p_{TE}: Rate of Occupancy Rate Improvement (activities for transport efficiency improvement) (%) Note: For the definition of p_{TE}, see the description of Option 2 in Methodology 9.2.	
$RMR_{i,y}$: Reference Occupancy Rate (%)	

(6) Reference Scenario and Project Boundary

【Reference Scenario of Project Activities and its Validity】

- The reference scenario is the continuance of the present taxi operation (vehicles, fuels, driving skills, dispatch practices).
- In large cities of many developing countries, the transport demand has been increasing apace with growing population and income and shifting from walk and bicycle to motor bike and automobile. As a result, the increased road traffic is intensifying inner city congestion and raising the fuel consumption per kilometer of travel. The volume of GHG emissions per vehicle kilometer keeps rising in urbanized areas. In Hanoi City where there is yet no mass transit as of 2013, CO_2 emissions per vehicle kilometer is on the rise and the trend is expected to continue through 2020, the year when the proposed project activities are scheduled to end.

Table 8 Forecast of Operational Speed in the Road Network of Hanoi (km/h)

2005 (actual)	2020 Forecast (BaU)	2020 Forecast (HAIDEP NW: Mass Transit Development)	
		Mass Transit Only	Mass Transit & TDM
26.0	9.4	22.0	35.2

Source: Study Report on The Comprehensive Urban Development Programme in Hanoi Capital City, Vietnam (HAIDP), JICA, March 2007.

【Establishment of Project Boundary】

- The geographical boundary is the space encompassed by the administrative boundary in which the taxi fleet targeted for the proposed project activities is in operation.
- The physical boundary is the taxi fleet which will participate in a bundle of activities to improve vehicle/fuel efficiency and transport efficiency. Those facilities and services that are not under the direct management of taxi operators, such as road infrastructure, traffic demand management and public transport policies, are not included in the boundary.
- The emission calculation focuses on CO_2. However, if gaseous fuels are used, CH_4 (methane) emissions are included.
- It is necessary not to double-count the emission reductions by carefully excluding those vehicles in the taxi fleet which are participants in some other CDM projects or programs (PoA) or NAMA activities.

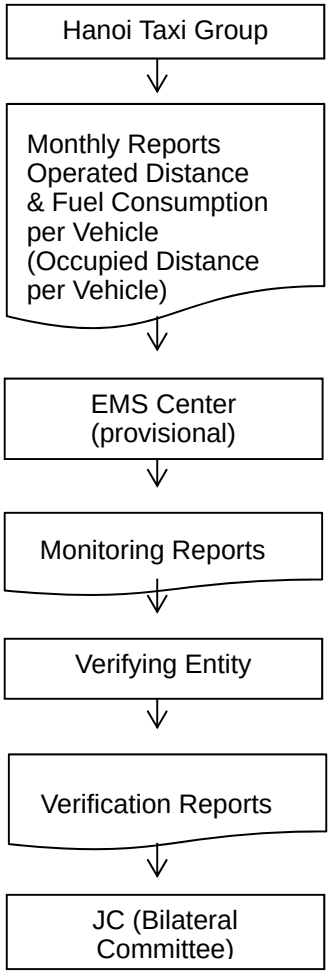
(7) Monitoring Methods

Methods and procedures of monitoring project activities are shown Table 8. In addition, the table indicates whether the suggested monitoring is actionable in the host country.

Table 9 Necessary Parameters and Monitoring Method, Procedure and Frequency

Parameter	Monitoring Method and Procedure	Frequency and Actionability
$DD_{i,y}$: Vehicle Operated Distance (km)	3) The data are collected from the monthly operational reports of taxi companies, or 4) Monthly operated distance is outputted to the spreadsheet from the logs of odometers	Monthly monitoring: Procedure 1) is actionable as part of monthly routine. Procedure 2) is additional. Measurable input data can be obtained when monthly operational reports are withheld.
$PFC_{i,x,y}$: With-Project Fuel Efficiency (L/km)	3) The data are collected from monthly operational reports of taxi companies, or 4) Monthly operated distance and fuel consumption are outputted to the spreadsheet from the logs of odometers	
$RFC_{i(x)}$: Reference Fuel Efficiency Rate (L/km)		Monthly monitoring for the duration of preferably three years or at least one year prior to the start of fuel efficient improvement activities: Procedure 1) is actionable as part of monthly routine. Procedure 2) is additional. Measurable input data can be obtained when monthly operational reports are withheld.
RMR_i: Reference Occupancy Rate (%)	1) Monthly operational reports are collected from operation managers, or 2) Monthly operated distance and occupancy rates are outputted to the spreadsheet from the logs of taxi meters.	
$PMR_{i,y}$: With-Project Occupancy Rate (%)		Monthly monitoring: Actionability is the same as mentioned above

The flow chart and the institutional arrangement for monitoring activities are shown in Figure 2 below.



Hanoi Taxi Group (HTG) is to provide the monthly operational reports of the last three years or the last year for monitoring by the EMS Center (provisional). If the reports are inadequately compiled or willfully withheld by taxi companies, the start of the proposed project activities will be postponed one year, during which an appropriate option will be chosen and implemented to obtain operated distance and fuel consumption of the target taxi fleet. Regarding transport efficiency, occupied distance must be added to monitoring.

The EMS Center (provisional) is to formulate a project monitoring program in consultation with HTG. The Center will determine various parameters such as the reference emission factor and the rate of efficiency improvement before the start of the activities and regularly collect basic data to calculate annual operated distance and fuel consumption throughout the project period and thereby estimate the realized emission reductions. The Center is to prepare annual monitoring reports.

A verifying entity must be selected from the independent third party organizations that possess DOE experiences regarding CDM projects in Viet Nam and are formally registered as qualified entities in the transport sector.

Prior to the start of the project activities, the verifying entity is to confer with the EMS Center and formulate a verification plan which is consistent with the monitoring program.

The monitoring report and the verification report are to be prepared annually.

The annual monitoring and verification reports are to be submitted to JC (bilateral committee) for its approval

Figure 2 Monitoring Procedure

(8) GHG Emissions and Reductions

【Measuring methods of Reference Emissions and Project Emissions】

Case of Option 2 of Calculation Method 1:

Table 10 Reference Emissions and With-Project Emissions

Reference Emissions	With-Project Emissions
$REF_{VE,i,y} = PEF_{VE,i,y} / \left(1 - p_{VE} \right)$ $RE_{VE,y} \sum_{i} \left(REF_{VE,i,y} \times DD_{i,y} \right)$ Where,	$PEF_{VE,i,y} = PFC_{i(x),y} \times NCV_{x} \times EF_{CO2,x}$ $PE_{VE,y} = \sum_{i} \left(PEF_{VE,i,y} \times DD_{i,y} \right)$ Where,

$REF_{VE,i,y}$: Reference emission factor of vehicle type i for the y^{th} year (gCO2/km) $PEF_{VE,i,y}$: With-project emission factor of vehicle type i for the y^{th} year (gCO2/km) $p_{VE,i(x)}$: Rate of fuel efficiency improvement of vehicle type i (%) $RE_{VE,y}$: Reference emissions for the y^{th} year (tCO2/y) $DD_{i,y}$: Annual total operated distance of vehicle type i for the y^{th} year (km/y)	$PEF_{VE,i,y}$: With-project emission factor of vehicle type i for the y^{th} year (gCO2/km) $PFC_{i(x),y}$: With-project fuel consumption of vehicle type i for the y^{th} year (L/km) NCV_x : Net calorie emission of fuel type x (J/L) $EF_{CO2,x}$: CO_2 emission factor of fuel type x (gCO_2/J) $PE_{VE,y}$: With-project emissions for the y^{th} year (tCO2/y) $DD_{i,y}$: Annual total operated distance of vehicle type i for the y^{th} year (km/y)

【Outputs from the Process of Calculating GHG Emission Reductions】

Table 11 Estimated GHG Emission Reductions by HTG Project Activities

Parameter	Parameter Calculation or Parameter Source	Output
$DD_{i,y}$: Annual total operated kilometers	Target fleet of 2,100 taxis Annual total operated distance of 55,073 km/vehicle	115,653,300 km
$PFC_{i,x,y}$: With-Project fuel consumption per km	Estimated from the monitored performances (fuel consumption and rates of improvement in fuel efficiency) by participants in the eco drive training program over the period of 7 months	0.0712 L/km
$NCV_{x,y}$: Net calorie emission	IPCC default (averaged)	32.81 GJ/kl
$EFCO_{2,x,y}$: CO_2 Emission Factor	IPCC default (averaged)	0.0693 tCO2/GJ
P_{ve}: Rate of improvement in fuel efficiency	Average of the performances by the participants in the eco drive training program	5.1 %
PE: With-Project Emissions	Obtained by calculation	18,721 tCO2/y
RE: Reference Emissions	Obtained by calculation	19,727 tCO2/y
ER: Emission Reductions	Obtained by calculation	1,006 tCO2/y

【Estimated Potential Emission Reductions by the Proposed Project Activities】

The taxi fleet in Hanoi City (population of 2.95 million in 2011 according to the UN world urbanization prospects) is 18,000 vehicles as of 2012. Other major cities in the country are Ho Chi Minh (pop. 6.19 million), Can Tho (pop. 1.4 million), Hai Phong (pp. 1.08 million) and Da Nang (pop. 0.96 million). Supposing that the number of taxis per population in Hanoi be applicable to other four cities, five cities have some 77,000 taxies plying their streets. If the eco drive activities are put into practice in all five cities, the expected emission reductions will be as indicated in Table 12 below.

Table 12 Estimated Emission Reductions by Project Activities in Hanoi and Viet Nam

Parameter	Unit	Hanoi City Only	Viet Nam (Five Cities)
Participating Vehicles	vehicle	18,000	77,000
Annual Average Operated Distance per Vehicle	km/ vehicle/ year	55,073	55,073
Rate of Fuel Efficiency Improvement	%	5.1	5.1
Vehicle Type		TOYOTA-vios	TOYOTA-vios
PE: With-Project Emissions	tCO_2/y	85,860	367,290
RE: Reference Emissions	tCO_2/y	95,400	408,100
ED: Emission Reductions	tCO_2/y	9,540	40,810

(9) Third Party Verification of Emission Reductions

Third party verification candidates for the present JCM/JCM project activities in the transport sector need to satisfy two conditions: namely, 1) they have satisfactory experiences in planning and implementing transport sector projects and 2) they have the experience of acting as a designated operational entity (DOE) either in the validation process or in the verification/certification process of CDM-approved project activities. Table 13 shows the parameters subject to the monitoring by the project operational entity and the verification by the third party verifying entity and Table 14 indicates the content and the method of third party verification. In Table 13, ◎ stands for the parameters which will be monitored and verified regularly during the project period, ○ stands for the project-specific parameters which are determined at the start of the project activities and subject to later verification and N.A. are the parameters not for verification.

Table 13 Monitored Parameters Subject to Third Party Verification

Parameter for Monitoring	Methodology 1			Methodologies 2 & 3		
	Op. 1	Op. 2	Op. 3	Op. 1	Op. 2	Op. 3
Operated Distance (km):	◎	◎	◎	◎	◎	◎
With-Project Fuel Consumption (L/km):	◎	◎	◎	◎	◎	◎
Reference Fuel Consumption (L/km):	○	N.A.	◎	○	N.A.	◎
No. of Vehicles (vehicle):	○	○	○	○	○	○
With-Project Occupancy Rate (%):	N.A.	N.A.	N.A.	◎	◎	◎
Reference Occupancy Rate (%):	N.A.	N.A.	N.A.	○	N.A.	◎
Rate of Fuel Efficiency Improvement: P_{ve}	N.A.	○	N.A.	N.A.	N.A.	N.A.
Rate of Occupancy Rate Improvement: P_{te}	N.A.	N.A.	N.A.	N.A.	○	N.A.

Table 14 Content and Method of Verification on Emission Reductions

Initial Verification:

	Description
Purpose	The purpose of the initial verification is to ascertain three points: namely, 1) whether the project activities are being put into practice as programmed, 2) whether the monitoring system is properly established and sufficiently capable of carrying out its mandate and 3) whether the project activities are likely to achieve the expected emission reductions.
Items for Verification	1) Issues and conditions of the project activities 2) Evaluation of whether the project activities are appropriately put into implementation 3) Sources of externally available data 4) Environmental and socio-economic indicators 5) Project management and operation systems
Method and Procedure	Desk Review → On-site Assessment → Draft Initial Verification Report → Initial Verification Report → Initial Verification Declaration

Verification at Regular Intervals:

	Description
Purpose	✓ To ascertain whether the operative monitoring system and procedure conform to the stipulations of the monitoring plan ✓ To assess the reported GHG emission reductions by checking whether the reports contain serious errors or omissions and guaranteeing with adequate evidence the high, if not perfect, performance of the project activities ✓ To ascertain whether the reported figures on emission reductions are sufficiently proven by the available records of monitoring and other factual evidences.
Risk-based Verification Approach	The most important focus of verification is to check and assess the following issues: whether emission factors are properly determined and applied; whether fuel consumption forecasts are accurate; whether conversion factors are properly used; and whether the estimation of emission reductions is consistently done. Furthermore, detailed auditing might reveal some other factor that seriously influences the reduction outcome. “Serious influence” in this case means that the estimated reductions are lowered by 5% or more.
Rules of Verification	1) Compliance with the Monitoring Plan 2) Materiality and Accuracy 3) Coverage 4) Quality of Evidence
Method and Procedure	Desk Review → On-site Assessment → Verification Report

Verification of Parameters:

Parameter	Proposed Verification Method
$N_{i(x),y}$: No. of Vehicles	A complete registry of the target taxi fleet is prepared to record their makes, initial dates of registration, displacement

	volumes, fuel types, seating capacities and so on. The accuracy of vehicle type classification is verified by inspecting such documents as registration certificates and manufacturers' specs. If a sample survey is chosen, the sampling method is checked to see whether it is statistically valid and put into practice truthfully.
$DD_{i,y}$: With-Project Operated Distance (km)	The existing formats of monthly operational reports are examined to see if they contain relevant data. If found inadequate, taxi operators would be asked to modify or revise them. Monthly reports are checked to see whether the data are properly entered as stipulated by the formats. The data in the reports are verified by checking whether they tally with odometer logs.
$PFC_{i,x,y}$: With-Project Fuel Consumption (L/km)	Monthly reports are checked to see whether the data are properly entered as stipulated by the formats. Relevant documents such as authentication certificates of fuel pump gauges, statements of delivery and invoices from fuel suppliers are inspected to verify the accuracy of total fuel consumption figures.
$RFC_{i,x,y}$: Reference Fuel Consumption (L/km)	Regarding total operated kilometers and total fuel consumption that are used for calculating the reference fuel consumption, the verification is similar to the ones indicated for $DD_{i,y}$ and $PFC_{i,x,y}$ above.
$PMR_{i,y}$: With-Project Occupancy Rate	The monthly reports are scrutinized to see the accuracy of recording.
$RMR_{i,y}$: Reference Occupancy Rate	The monthly reports during the monitoring period are checked to see whether the recorded data are sufficiently reliable to use for calculation of the reference occupancy rate.
P_{VE} : Rate of Fuel Efficiency Improvement P_{TE} : Rate of Occupancy Rate Improvement	The period of monitoring and the size of samples are checked to see whether they are valid for calculating the respective rates of improvement in fuel efficiency and occupancy rate. The process of calculation is scrutinized to see whether it contains some idiosyncratic input or output. When the fuel efficiency is taken from the manufacturer's catalog, the catalogued value is checked to see the validity of measurement.

(10) Preparedness for Environmental Impact

The proposed project activities will reduce the consumption of fossil fuels. In this sense, they will contribute to the reduction of air pollution by automobile emissions, by ameliorating the roadside atmospheric conditions. It will be necessary to foresee, however, adverse environmental impacts of fuel efficiency improvements. For example, a certain type of vehicle retrofitting might cause some malfunction of the carburetor that is difficult to adjust, thus worsening air pollution. It is thus essential to be prepared for such possibilities and institute preventive measures beforehand.

The National Strategy for Climate Change announced by the Vietnamese government stipulates that buses and taxis will shift to compressed or liquefied natural gas at an accelerating pace and that the users of such fuels will reach 20% by 2020 and 80% by 2050. The proposed project activities are expected to play a large role in serving the national strategy. It must be noted that the present project activities are not subject to the environmental assessment system established in Viet Nam.

(11) Comments from Stakeholders

Stakeholders were asked for their comments during the 5th field survey (latter half of January 2013). Their opinions are summed up in the table below.

Table 15 Stakeholders' Comments

Stakeholder	Comment
Hanoi Taxi Group (HTG)	They acknowledge the positive effect of eco drive activities but think that the suggested smartphone technology is too costly and difficult to manage. Instead, they would prefer to organize the internal education and training program for drivers on efficiency improvement activities. They also prefer to weigh the introduction of low-carbon vehicles in terms of cost and CSR.
Ministry of Transport	They hold the view that the monitored effect of eco drive activities agree with their initial expectation. Some interviewees voice the need of extending the Study to cover the entire HTG fleet. They agree that hybrid cars will bring considerable impacts on the future motorized traffic in Viet Nam and that they are prepared to support their introduction.
Project Operational Entity: EMS Center (provisional)	The University of Transport Technology (UTT) appears to be a suitable operational entity, since it has been implementing its own eco drive promotion project. The Institute of Planning and Transport Engineering (IPTE), the collaborator of the present Study, is of the opinion that the introduction of low-carbon vehicles will have greater impacts than the eco drive campaign and that the provisionally proposed EMS Center will be established with that assumption.
Automobile Manufacturers and Dealer	Some interviewees are apprehensive about fitting the OBDII data logger to the target taxis. Regarding the issue of hybrid cars, they think that the possibility in Viet Nam will have to be worked out in their corporate strategy for global marketing.

(12) Institutional Development for Project Implementation

Figure 3 shows the institutional setup for the operational entity of the proposed project activities and other collaborating/participating authorities and organizations, including the possibility of expanding the project scope to a more generalized scheme in the future.

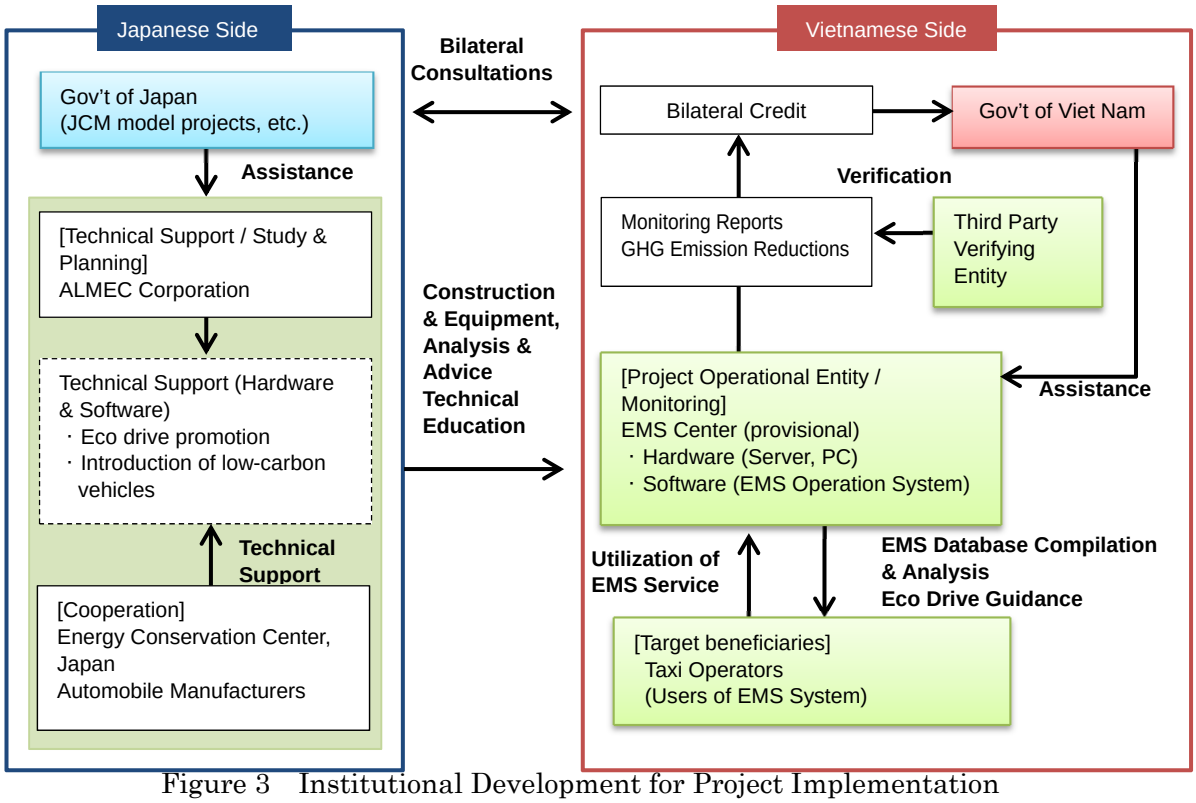


Figure 3 Institutional Development for Project Implementation

The provisionally proposed EMS Center would be the focus of efficiency improvement activities. The Center retrieves various data logged by EMS apparatuses installed to the vehicles in operation and centrally manages the compilation and analysis of the collected database. The Center also undertakes the monitoring over project activities and calculates emission reductions. The Center will feed back the results of their data analyses to the respective vehicles (users of EMS services) and offer eco drive guidance. In other words, the Center acts as the operational entity that promotes eco drive campaigns. The proposed general scheme will be supported by the Japanese side with the software development for EMS-related analyses and further advices on eco drive activities.

(13) Financial Planning

The project activities will be financially self-sustainable on their own during the project period. External finance is needed to meet the initial investment and the startup operational cost. Considering the participation by many taxi companies, a two-step program loan would be provided from the JBIC fund.

Table 16 Assumptions for Financial Planning

Target fleet (no. of vehicles)	2,100
Fuel efficiency without project (L/km)	0.0751
Fuel efficiency with project (L/km)	0.0712
Fuel efficiency improvement (L/km)	0.0039

Annual operated distance per vehicle (km/vehicle/year)	55,073
Reduction of annual fuel consumption per vehicle (L/vehicle/year)	214.7847
Reduction of annual CO_2 emissions per vehicle (tCO_2/vehicle/year)	0.47909
Unit fuel cost (¥/L)	90
Value of offset credit on CO_2 emission reductions	1,000
Annual saving on fuel consumption per vehicle (¥/vehicle/year)	19,331
CO2 emission reductions per vehicle (¥/vehicle/year)	479

Table 17 Project Cost and Revenue

Cost Item	No. of Units	Unit	Unit Price	Cost (¥)
EMS Apparatus	2,100	kit	15,000	31,500,000
Center System (hardware)	1	set		5,000,000
Center System (software)	1	set		5,000,000
Commission Payments by Taxi Companies to the Center				11,000,000
Annual Cost of EMS Transmission	2,100	kit	5,000	10,500,000
Annual Operational Cost of the Center (other than personnel cost)				5,000,000
Annual Operational Cost of the Center (personnel salaries and wages)				5,000,000

The expected credit to be certified on the project emission reductions will not be very large. However, the effect of energy conservation (saving on fuel consumption) is considerable, enabling the taxi operators to save some ¥40 million annually. The EMS Center, the provisional operational entity of the project activities, would be sustainable by charging the taxi companies the commissions worth 30% of their energy savings. If the project scope be expanded to include other vehicles, the Center would be able to earn profits.

Table 18 Financial Statements

Taxi Companies: (thousand yens)

Year	Expenditure				Revenue	Cash Flow
	EMS Apparatus	EMS Transmission Cost	Commissions Paid to EMS Center	Subtotal	Saving on Fuel Consumption	
0	31,500	10,500	11,000	42,500		-42,500
1		10,500	11,000	21,500	40,594	19,094
2		10,500	11,000	21,500	40,594	19,094
3		10,500	11,000	21,500	40,594	19,094
4		10,500	11,000	21,500	40,594	19,094
5		10,500	11,000	21,500	40,594	19,094
6		10,500	11,000	21,500	40,594	19,094
7		10,500	11,000	21,500	40,594	19,094
Total	31,500	73,500	88,000	193,000	284,160	41%

EMS Center: (thousand yens)

Year	Expenditure			Revenue			Cash Flow
	Center System	Center Operational Cost	Subtotal	Credit	Commission Receipts	Subtotal	
0	10,000	10,000	20,000	1,006	11,000	12,006	-7,994
1		10,000	10,000	1,006	11,000	12,006	2,006
2		10,000	10,000	1,006	11,000	12,006	2,006
3		10,000	10,000	1,006	11,000	12,006	2,006
4		10,000	10,000	1,006	11,000	12,006	2,006
5		10,000	10,000	1,006	11,000	12,006	2,006
6		10,000	10,000	1,006	11,000	12,006	2,006
7		10,000	10,000	1,006	11,000	12,006	2,006
Total	10,000	80,000	90,000	8,049	88,000	96,049	16%

Combined Total: (thousand yens)

Year	Expenditure			Revenue			Cash Flow
	Taxi Companies	EMS Center	Subtotal	Taxi Companies	EMS Center	Subtotal	
0	42,500	20,000	62,500	0	12,006	12,006	-50,494
1	21,500	10,000	31,500	40,594	12,006	52,600	21,100
2	21,500	10,000	31,500	40,594	12,006	52,600	21,100
3	21,500	10,000	31,500	40,594	12,006	52,600	21,100
4	21,500	10,000	31,500	40,594	12,006	52,600	21,100
5	21,500	10,000	31,500	40,594	12,006	52,600	21,100
6	21,500	10,000	31,500	40,594	12,006	52,600	21,100
7	21,500	10,000	31,500	40,594	12,006	52,600	21,100
Total	193,000	90,000	283,000	284,160	96,049	380,209	37%

(14) Introduction of Japanese Technologies

Japan has been promoting eco drive activities for many years and developed an array of equipment and apparatuses and the expertise in eco drive practices. The eco drive practices not only realize energy conservation but reduce traffic accidents and the cost thereof. Because of the direct and tangible economic gain, it is relatively easy to promote a package of eco drive hardware and software among busing and trucking businesses. Regarding other types of automobile use, educational campaigns and training programs of driving techniques are known to realize slower but steady improvement of fuel efficiency without installation of any specialized apparatuses. In addition to the eco drive technology and knowhow, there are other types of technology and expertise in Japan which can be put to effective use in other countries, as mentioned below.

① Taxi Dispatch System

The Hanoi Taxi Group has already installed GPS to the entire fleet and started using a new dispatch system. The provider of the system is BINH ANH Electronics Company of Viet Nam. Terminal units installed to taxis provide GPS services and possess packet communication capability of displaying real time positions of taxis in the monitor of the dispatch center. At the present moment, the capability is not efficiently put to use. For example, a passenger request received by the dispatch center is radioed to a number of taxis found close by, and whichever taxi comes first in response is assigned to pick up the passenger. (The taxi radio system currently in use allocates a different frequency band per group of ten taxis. Thus, it is not possible to call up a particular taxi by the radio.) Although there is some room for improvement in the operation of the newly introduced system, it does not appear necessary to introduce a Japanese dispatch system.

② Introduction of ICT (information and communication technology) to Fare Charging

The on-going Hanoi Public Transport Improvement Project, a JICA-supported technical

assistance project, aims to introduce ICT commuter tickets (Felica) to bus services in Hanoi. At present, a pilot project is being formulated for some selected bus lines.

Public transport means like railways and regular bus lines are yet inadequately developed in Hanoi. Consequently, taxis play a large public role by transporting visiting tourists and school and other commuters. There is a definite merit to ICT ticketing for taxi passengers. ICT tickets usable for both bus and taxi rides will improve the user convenience of public transportation and in the end contribute to an increase of public transport users. ICT ticketing will enhance the capability of transport service providers to collect and analyze relevant data on passenger behaviors and thereby improve the quality of service by better operation and management.

③ Introduction of Low-carbon Vehicles

Fuel efficiency improvements by taxi service providers will reduce not only GHG emissions but the fuel consumption per vehicle kilometer and raise the profitability of taxi operation. When assured of business advantage, taxi companies are expected to take more forward steps in fuel efficiency improvement. The most effective measure for fuel efficiency improvement is to introduce low-carbon vehicles. Hybrid cars, for example, will cut down fuel consumption by 30% or more compared with vehicles of conventional internal combustion engines. This improvement is 6 times larger than 5% of the monitored taxi operation during the Study. Electric cars are not free from GHG emissions because 80% of electricity in Viet Nam is generated by fossil fuels.

Hybrid cars cost more than the conventional combustion engine vehicles, but their operational cost is less. To compare in terms of aggregate life cycle cost, hybrid cars have an edge over conventional vehicles, the edge becoming larger as total life cycle operated kilometers increase. In this sense, the taxi operators could get the largest benefits out of hybrid cars among the automobile users. Currently, hybrid cars are hardly seen in Viet Nam, but their introduction to the taxi fleet could inspire other conventional automobile users to switch. The wider use of hybrid cars will bring greater emission reductions in the country.

Japanese automakers lead the world in hybrid car technologies, and yet hybrid cars are not sold in the regular market in Viet Nam. It is necessary to probe the feasibility of starting a general scheme for promoting the increased use of hybrid cars, following the initiative taken by the taxi operators as part of the present JCM/JCM-supported project activities.

Table 19 Life Cycle Costs by Vehicle Type

	Type V (ICE)	Type P (HV)	Type A (HV)	Remark
Initial Cost (¥'000)	1,070	2,170	169	Quoted from the automakers' home pages
Fuel Efficiency (km/L)	14.2	19.6	22.1	"e" fuel efficiency
Annual Operated Distance per Vehicle (km)	55,073	55,073	55,073	Average of HTG fleet
Fuel Price (¥/L)	90	90	90	Current price
Annual Fuel Cost (¥'000/year)	349	253	224	
Years in Use	7	7	7	Average of HTG fleet
Fuel Cost of 7 years (¥'000)	2,440	1,770	1,570	
Credit during 7 years (¥'000)		-16	-21	
Life Cycle Cost (¥'000)	3,510	3,920	3,240	

(15) Future Prospects and Issues

The present Study proposed, as a JCM project, a bundle of eco drive activities, considered the possibility of low-carbon vehicles which would have a much higher cost benefit ratio when introduced to the taxi fleet, and suggested a project scheme* with its provisional operational entity, the EMS Center.

> * The proposed scheme promotes eco drive activities under the management of the EMS Center. The Center is to collect and manage the data on taxi operation and feed the results of data analysis back to the target vehicles (ESM system users), including eco drive guidance. A new methodology of retrieving data from the taxis in operation need be devised to avoid the use of the OBDII connector monitored during the Study.

It must be noted, however, that the suggested scheme would require a sizable capital outlay and some period of preparation. Instead of taking immediate steps towards the establishment of the Center, it is better, for the time being, to establish a procedure or an approach which will encourage self-governance of the taxi operators regarding eco drive activities. More specifically, the texts used for training during the Study can be put to good use with appropriate updates so that the eco drive training program would be continued and expanded. The training course for eco drive instructors can be set up within Hanoi Taxi Group with technical support from the University of Transport Technology (UTT) that has been promoting its own eco drive promotion program for some time.

The future eco drive activities sustainable by the taxi operators are indicated in Figure 4.

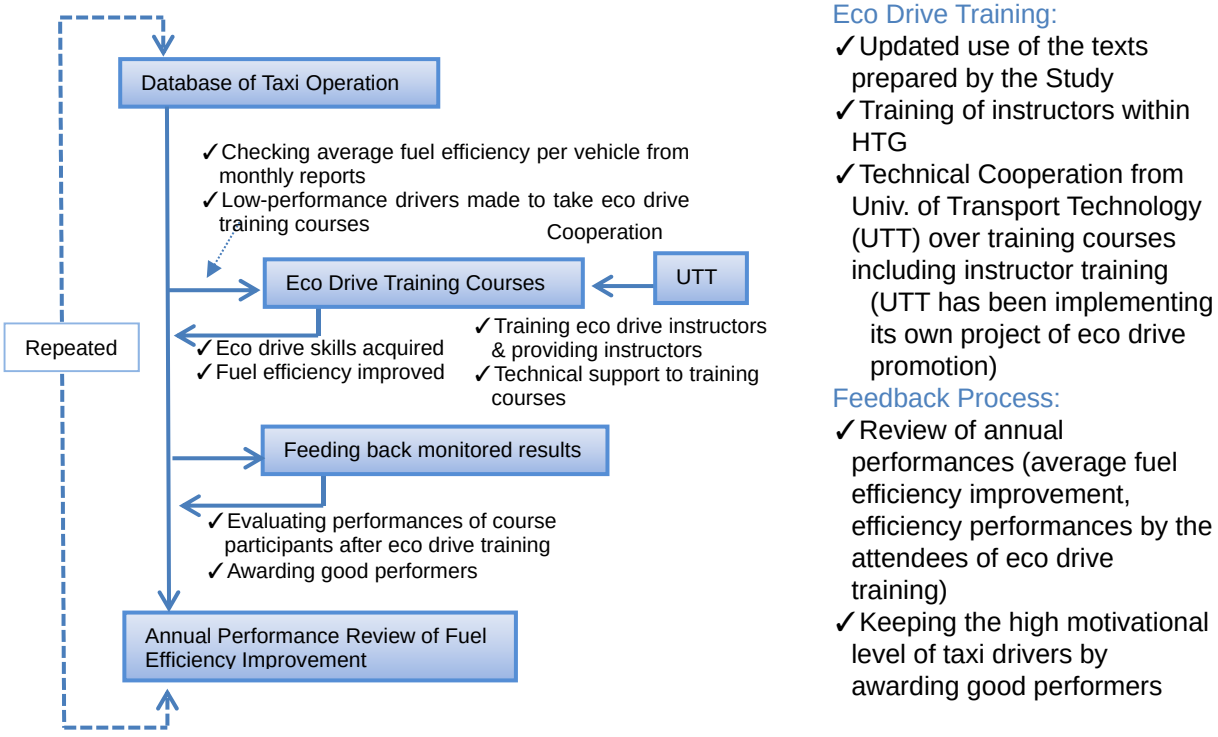


Figure 4 Institutional Setup for Sustainable Eco Drive Promotion

5. Contribution to Sustainable Development

In the National Strategy for Climate Change in Viet Nam, the policy stance regarding the reductions of GHG emissions emphasizes the importance of the transport sector. It stipulates that the emission reductions will be realized by promoting increased consumption of low-carbon fuels. Specifically, the shift of buses and taxis to compressed and liquefied natural gas is to be accelerated so that such fuels would reach 20% by 2020 and 80% by 2050 of their

total consumption.

The MRV methodology development by the present Study focuses precisely on the issue of fuel shift. The fuel shift combined with the eco drive promotion will be very effective in energy conservation.

The shift of gasoline and diesel to CNG will be made possible by kitting up the existing vehicles with the apparatuses developed and manufactured in Japan. The integrated introduction and promotion of such hardware and eco drive activities would be assured of emission reductions, subject to the measurement, reporting and verification carried out in accordance with the MRV methodologies developed by the present Study.