FIRST METHODOLOGY ASSESSMENT REPORT

"GHG EMISSION REDUCTIONS THROUGH CARPOOLING"

REPORT NO.
VCS.13.VAL.005

Methodology Title	GHG Emission Reductions Through Carpooling	
Version	2.1	
Methodology Category	Methodology	New Methodology
Sectoral Scope(s)	Sectoral Scope 7 (Transport Sector)	

Report Title	First Assessment Report of the new proposed methodology, "GHG Emission Reductions Through Carpooling"
Report Version	02.1
Client	*Greenmiles Technologies, LLC*
Pages	32

Date of Issue	*07-March-2014 report issued and reconciled on dated 12-March-2015*
Prepared By	KBS Certification Services Private Limited (KBS)
Contact	Registered Office: 414 -124, Om Shubham Tower, Neelam Bata Road, N.I.T., Faridabad, Haryana, 121003. India. Tel.: +91-129-4034513, 4054513, 403513, Fax: +91-129-4035139. Webpage: www.kbsindia.in; Email: info@kbsindia.in
Approved By	Mr. Kaushal Goyal (Managing Director)
Work Carried Out By	Mr. Sanjay Kandari (Team Leader) Mr. Gagandeep Kakkar (Validator) Priyanka Agarwal (Financial Expert) Mr. R S Mittal (Technical Expert 7.1)

Summary:

The purpose of this report is to document conformance of a methodology presented by "Greenmiles Technologies, LLC", hereafter referred to as "Methodology Developer", with the requirements of the Voluntary Carbon Standard (VCS). The methodology developer is the owner of the methodology under assessment for estimating the CO_{2e} emission reduction emission reductions from trip avoidance due to carpooling. The methodology was prepared by Greenmiles Technologies, LLC. This methodology is designed to enable the project developers to provide methods for determining emission reductions from trip avoidance due to carpooling. The methodologies thus far cover emission reductions in transport due to fuel switch, energy efficiency, or modal shift.

The assessment was based upon the following VCS documents:

- Voluntary Carbon Standard, Version 3.4 (October 8, 2013)
- Voluntary Carbon Standard, Methodology Approval Procedure, Version 3.5 (October 8, 2013)
- Voluntary Carbon Standard, Validation & Verification Manual

The validation team of KBS raised 01 CARs and 05 CLs during the assessment of proposed methodology and resolved it satisfactorily.

KBS completed the first assessment of the methodology in line to the recent, "Voluntary Carbon Standard, Methodology Approval Procedure" and concluded that the proposed new methodology, "GHG EMISSION REDUCTIONS THROUGH CARPOOLING, version 1 dated 24th October 2013" provides the appropriate methods to the project developers to account the emission reduction calculations by using the car pooling.

Abbreviations

CMA	Carpool Management Application
CMMS	Carpool Management & Monitoring System
CS	Carpool Server
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
FFVs	Fossil Fuel Vehicles
OBDII	On Board Diagnostics Specification Version 2
PID	Parameter Identification Code
PEV	Plug-In Electric Vehicle
PHEVs	Plug-In Hybrid Electric Vehicles
SOBT	Single Occupancy Baseline Trip Distance
SSC	Small Scale
US EPA	United State Environmental Protection Agency
VVB	Validation & Verification Body
VCS	Voluntary Carbon Standard
VVM	Validation & Verification Manual

Table of Contents

1 INTRODUCTION

1.1 Objective

The methodology was prepared by, "Greenmiles Technologies, LLC" and the proposed methodology is designed to enable the project development by using the car pooling and thereafter to account the emission reductions in terms of CO_2e. KBS assessed the methodology as a first VVB in line to the procedures defined in the VCS documents for the assessment of new methodology.

The assessment was based upon the following VCS documents:

- Voluntary Carbon Standard, Version 3.4 (October 8, 2013)
- Voluntary Carbon Standard, Methodology Approval Procedure, Version 3.5 (October 8, 2013)
- Voluntary Carbon Standard, Validation & Verification Manual

After reviewing the proposed methodology, KBS concluded that the methodology comply with the criteria set forth for the new methodology in the above mentioned documents.

1.2 Summary Description of the Methodology

This proposed methodology provides procedures to estimate the avoided net GHG emissions resulting from project activities involving use of carpools (and vanpools) for commuting (commuter carpools) in terms of CO_2e. In absence of project activities eligible to apply the proposed methodology the GHG emission could have been occurred due to the single occupancy vehicular trips in cars which use the fossil fuels or emission-intensive electricity for motive power and thereby reduction in GHG emission.

The emissions quantification by this methodology relies on the participation of individuals as members of carpooling community. Each member will agree to run a Carpool Management Application (CMA) on his or her smart phone. The CMA application running on each member smart phone reports trip details to a carpool server (CS) for occupancy and carpool membership detection and validation.

Project emissions are quantified by estimating the fuel consumption of eligible project managed carpool trips. Vehicle fuel consumption for each trip is estimated via either:

1) CMA reading parameters from vehicle engine control unit (ECU) over OBDII dongle,

or

2) CMA reading parameters for trip distance combined with manufacturer or government published fuel economy statistics.

Baseline emissions are quantified based upon the single occupancy vehicular trips that would have taken place in absence of the carpool, based on carpooling members' vehicle and trip information registered with the Carpool management and monitoring system (CMMS).

2 ASSESSMENT APPROACH

2.1 Method and Criteria

This assessment of a new methodology has been evaluated in line with guidance given under the VCS Program, as mentioned in the above section of this report.

The scope of this assessment includes:

i. Eligibility criteria. Assessment of whether the methodology's eligibility criteria are appropriate and adequate.

ii. Baseline approach: Assessment of whether the approach for determining the project baseline is appropriate and adequate.

iii. Additionality: Assessment of whether the approach/tools for determining whether the project is additional are appropriate and adequate.

iv. Project boundary: Assessment of whether an appropriate and adequate approach is provided for the definition of the project's physical boundary and sources and types of gases included.

v. Emissions: Assessment of whether an appropriate and adequate approach is provided for calculating baseline emissions, project emissions and emission reductions.

vi. Leakage: Assessment of whether the approach for calculating leakage is appropriate and adequate.

vii. Monitoring: Assessment of whether the monitoring approach is appropriate and adequate.

viii. Data and parameters: Assessment of whether fixed ex-ante data and monitored data/parameters used in emissions calculations are appropriate and adequate.

ix. Adherence to the project-level principles of the VCS Program: Assessment of the methodology adheres to the project-level principles of the VCS Program.

x. Assessment of public comments received during the public availability of methodology.

2.2 Document Review

A desk review is undertaken, involving but not limited to,

- A review of the data and information presented to verify their completeness;
- A review of the draft methodology;
- An evaluation of data management and the quality assurance and quality control system in the context of their influence on the generation and reporting of emission reductions.
- Cross-checks of data and information provided with documents provided and used for the validation.

2.3 Interviews

As this was the methodology assessment of the new proposed methodology therefore no site visit was undertaken however validation team interviewed the methodology developer Mr. Sohil Thakkar on skype and telephone.

2.4 Assessment Team

The assessment team is consist of the following team members:

Mr. Sanjay Kandari (Team Leader)

Mr. Gagandeep Kakkar (Validator)

Ms. Priyanka Agarwal (Financial Expert)

Mr. R S Mittal (Technical Expert 7.1)

2.1 Resolution of Findings

Summary of findings	CAR	CL	FAR
	01	05	00

Date	Type & Number	Raised by	Reference
02/12/2013	CAR#01	Assessment Team	VCS Standard/Procedure
Non conformities raised			
The latest template for methodology version 3.3 available at VCS website is not used to prepare the document.			
Project participant response		Date: 04/12/2013	
Method was submitted to VCS on Oct. 3 2013, before version 3.3 template was published by VCS. VCS staff updated the document after the submission with necessary formatting changes. Additional formatting changes			

identified by VVB are incorporated in the document attached		
Documentation Provided as Evidence by Project Participant		
Document name: VCS Methodology Carpool v1.1rsp-v2.docx		
Information Verified by Lead Assessor	Date of review: 28/12/1013	
Revised Methodology		
Reasoning for not acceptance or close out		
The methodology template has now updated by the methodology developer, the assessment team has checked that the updated template is the recent version available on VCS website.		
Date of acceptance ~~or non expectance~~	Date: 02/01/2014	Status: Closed.

Date	Type & Number	Raised by	Reference
02/12/2013	CL # 02	Assessment Team	VCS Standard/Procedure
Non conformities raised			
a. Section 4.1 of applicability condition point no.3- Does this prevent the project from being able to use the methodology? Can there be procedures to address this elsewhere within the methodology instead of including this as an applicability condition? b. Section 4.2 of applicability condition point no.2 - Does this criterion cover the ownership of vehicle? c. Section 4.2 of applicability condition point no.3 – Is CMA a proprietary technology? If yes please clarify how it is complying with the section 5.2.1 of VCS VVM version 3.1.			
Project participant response	Date: 04/12/2013		
Sec. 4.1 – applicability condition removed from point no. 3 and added condition requiring that MIL light be off when estimating fossil fuel consumption using data obtain from querying carpool vehicle ECU. Sec. 4.2 – Condition relaxed so that only if member owns the private vehicle, he/she is required to register that vehicle as a baseline trip vehicle. Updated monitoring section to allow for members without vehicle ownership. Sec. 4.3. The carpool server (CS), OBDII device and carpool management application (CMA) are generic components needed for monitoring carpool members and vehicles. Though Greenmiles has developed proprietary and patented technology enabling automatic carpool monitoring using these components, any other vendor may develop technology using these components without infringing on Greenmiles technology. Greenmiles technology is available to all project proponents and developers on negotiated business terms.			
Documentation Provided as Evidence by Project Participant			
VCS Methodology Carpool v1.1rsp-v2.docx			
Information Verified by Lead Assessor	Date of review: 28/12/2013		
Revised Methodology			
Reasoning for not acceptance or close out			

a. The methodology has been updated for the sought corrections, CL is closed. b. The methodology has been now updated for more clarity in the updated version of methodology, CL is closed. c. The explanation provided by the methodology developer is accepted, CL is closed.		
Date of acceptance ~~or non expectance~~	Date: 26/02/2014	Status: Closed.

Date	Type & Number	Raised by	Reference
02/12/2013	CL # 03	Assessment Team	VCS Standard/Procedure
Non conformities raised			
Section 5 Project Boundary Please clarify why emissions due to electricity for powering the central carpool server is considered as leakage emissions instead of project emission?			
Project participant response		Date: 04/12/2013	
Primary project activity is carpooling which are directly related to avoided SOBTs. Carpool members directly control their carpooling activities. Emissions from carpool server are not under the control of carpool members and may not be in direct control of project developer when CS is deployed in the cloud. Hence emissions from carpool server are considered leakage (i.e. secondary emission) instead of project emission. It should also be noted that emission from CS is insignificant compared to emission reduction from carpooling.			
Documentation Provided as Evidence by Project Participant			
VCS Methodology Carpool v1.1rsp-v2.docx			
Information Verified by Lead Assessor		Date of review: 28/12/2013	
Revised methodology			
Reasoning for not acceptance or close out			
The contention provided by the methodology developer is acceptable. CL is closed.			
Date of acceptance ~~or non expectance~~		Date: 02/01/2014	Status Closed.

Date	Type & Number	Raised by	Reference
02/12/2013	CL # 04	Assessment Team	VCS Standard/Procedure
Non conformities raised			
1. Section 7 additionality demonstration step 2 - Are these criteria and procedures well detailed and provide a step-wide approach to determining additionality? Please review this against the level of detail within the CDM Additionality Tool for consistency in details. 2. Section 7 additionality demonstration step 3 - Are these criteria and procedures consistent with the guidance provided in the GHG Protocol for Project Accounting?			

Project participant response	Date: 04/12/2013

1. Section 7 step 2:

   Technology barrier: Alternate to project activity is driving alone which doesn't face significant technology barrier of finding another rider or managing drive alone rides to/from work.

   Institutional barrier: Convenience of driving alone to/from work is significant and hence significant portion of commuters drive alone. Activities like preferred carpool parking spot or other encouragement from employer (or even local governments) increases convenience factor for carpooling and hence helps lowers the institutional barrier to carpooling.

   Recognition as well as quantified carbon credits from VCS registered project for carpooling activities enables employer and project proponent to allocate financial resources to encourage carpooling activities and measure return on those investment in terms of emission reductions.

2. Section 7 step 3:

   This is consistent with section 7.4.2 and 7.6 of GHG protocol for project accounting reference book indicated by VCS standard. Specifically, section 7.4.2 specifies that when there is larger diversity of baseline candidates dominant technology may have lower penetration rate verses when there is few alternate technologies, dominant technology will have higher concentration. In both case, identification of dominant technology is needed. Step one specifies requirement to identify dominant technology i.e. mode of commuting. Project activity/technology is not a common practice if it is not a dominant technology as required by step 2.

   Use of HHI index provides procedure to comply with common practice test when one or two mode of commute is prevalent (i.e. commuting mode market is oligopoly or monopoly market).

Documentation Provided as Evidence by Project Participant	
VCS Methodology Carpool v1.1rsp-v2.docx	
Information Verified by Lead Assessor	Date of review: 20/02/2013
Revised Methodology document	
Reasoning for not acceptance or close out	

1. The additionality section in the updated version of methodology has been revised by the methodology developer and all the alternatives to the carpooling are included in the additionality section to test the additionality of projects which would apply the proposed methodology. The step wise additionality demonstration has an analogy to the CDM additionality determination guidance for the SSC activities and also in compliance to VCS VVM.
2. The updated version of methodology comply the additionality criteria with the VCS VVM and has an analogy with the CDM additionality guidance EB 68, Annex 27 and CDM SSC guidance for the alternative selection of project activities applying the methodology.

Date of acceptance ~~or non expectance~~	Date: 28/12/2013	Status: 20/02/2014

Date	Type & Number	Raised by	Reference
02/12/2013	CL # 05	Assessment Team	VCS Standard/Procedure
Non conformities raised			
Section 9 Monitoring 1. Description of parameter Vc, Rc and Wc is not consistent with other sections of the document. 2. It is not clear what the difference in private VIN and actual VIN is? Please clarify 3. Section 9.3 point no. 5 - Is the recorded trip information not automatically reported by CMA application from smart phone? Please clarify. 4. "Carpool trip thus constructed can have one or more sub-trips with few single occupancy sub-trips, one or more sub-trips with different but non-disjointed sub-trip membership set" – Please elaborate this statement.			
Project participant response		Date: 04/12/2013	
1. Updated those sections to read VIN number instead of "number" to make it consistent across the document. 2. Carpool vehicle VIN is learned by CMA during carpool trip. This VIN number provides vehicle's make/model/year information so that efficiency factors (Vc, Rc and Wc) can be obtained by government or manufacturer for the carpool vehicle. During registration process member provide make/model/year information of SOBT vehicle. Private VIN is created to tie this make/model/year information to specific member providing consistence in implementation. Similarly for member who don't own private vehicle, national/regional averages of vehicle efficiency parameter is tie to hypothetical make/model/year and to a private VIN. 3. Section 9.3 point no. 5. Trip information is reported by CMA automatically. There is no reason to report trip information to CS in real-time. Because this relates to specific implementation and as such don't affect method this point is deleted. 4. This statement and associate full sub-section is removed and replaced with statement: Determine carpool membership set.			
Documentation Provided as Evidence by Project Participant			
VCS Methodology Carpool v1.1rsp-v2.docx			
Information Verified by Lead Assessor		Date of review: 28/12/2013	
Revised methodology document			
Reasoning for not acceptance or close out			
1. The revised methodology document has been updated by the methodology developer for the sought corrections and assessed appropriate by the assessment team. CL is closed. 2. The clarification is accepted. CL is closed. 3. The methodology has been revised and elaborated with respect to sought clarification. Assessment team assessed it adequate. CL is closed. 4. The methodology has been updated with respect to sought clarification. Assessment team assessed it adequate. CL is closed.			
Date of acceptance ~~or non expectance~~		Date: 28/12/2013	Status: Closed.

Date	Type & Number	Raised by	Reference
02/12/2013	CL # 06	Assessment Team	Public comments

Non conformities raised

Please address the following public comments:

In particular, the use of HHI to test common practice seems intriguing. However, I am not sure if the analogy to monopoly markets really robust, because

- Passenger transport is not one market with "free choice of company" (mode), such as a national cellphone market, but rather a patchwork of many overlapping sub-markets of groups of passengers with varying access and costs for different modes
- The sub-market of passengers that has actually potential access to the company/mode "car pooling" is much smaller than the entire transport by car/truck/van: It is restricted to people that (i) commute and (ii) have similar points of Origin and Destination for their commute to be able to share and (iii) where at least one of the sharing group owns and drives a car. Based on this, the current share of car pooling in your example may be a much higher share of the sub-market than the 6.7% you mention.

On the other hand, car pooling of people that have the same O-D and do not know of each other is very rare in absence of established car pooling organizations. Here, the additionality argument could be much simpler.

Project participant response	Date: 12/4/2013

Market definition is very important for applying HHI index method. If market is defined too narrowly, all markets would be monopoly with single firm whereas if defined too widely it would result in perfectly competitive market. The purpose associated with determining market concentration should guide the market definition. For example, if purpose is to determine which company/firm has leadership position in zero tail-pipe emission vehicles, market is defined as "market of all PEV". Clearly in this case Telsa Motors would come on top as the market leader. However, if purpose is to determine which vehicle type is most prevalent in the private vehicle market (for providing preference to one over other type like in California which allows single occupant Hybrid/PEV/PHEV vehicles to use High Occupancy Vehicle (HOV) lanes) -- where vehicle types are PEV, PHEV, Hybrid and FFV,-- then FFV would top the chart. Affordability of specific vehicle type to general population is not a factor in either of the two cases.

In case of carpool methodology, "a mode of transportation to go to work (or earn living)" is a service used by all commuters. Commuter decides one mode or other -- including work from home -- based on their individual circumstance and use of HHI index is to determine which technology/mode of commuting to work is dominant in given geographic area to determine common practice, irrespective of whether particular mode is feasible for all commuters or only partial set. Goal is NOT to determine potential size of carpool market and relative penetration of carpooling rather goal is to determine penetration of carpooling relative to other modes of transportation in given geographic area for determination of common practice. (ch. 7.4.2 greenhouse protocol). HHI index is used to determine if diverse mode of transportation is present or not as determine by HHI threshold 0.25. HHI index greater than 0.25 signifies market dominated by one or two firms/modes.

When computing HHI index, only people who commute to work are counted, including people working from home (as correctly identified in point 2(i) and accounted for in the method). Point 2(ii) doesn't necessarily

apply based on above argument. In addition, O and D don't need to be "similar" -- any O and D are okay as long as passenger O-D and driver O-D shares significant common route. In addition availability of carpool parking lot at major highway exits and spoke model of many metro mean set of commuter who can carpool is significantly larger than implied in point 2(ii). Point 2(iii) really doesn't apply because if time-efficient commute via a private vehicle is possible, carpool would enable it when commuter couldn't drive or afford a vehicle (instead of either reduce employment opportunity or requiring long time-commute via public transportation). On other hand, if commuter can drive/afford vehicle, he is likely using drive-alone private vehicle to commute in absence of carpool.		
Documentation Provided as Evidence by Project Participant		
VCS Methodology Carpool v1.1rsp-v2.docx		
Information Verified by Lead Assessor	Date of review: 20/022014	
Response of methodology developer		
Reasoning for not acceptance or close out		
The explanation provided by the methodology developer in response to the public comment in context of common practice deemed appropriate in view of the financial expert in the assessment team. The financial expert also convinced the selection of market in order to compute the HHI index. HHI is widely accepted principle to measure of the size of firms in relation to the industry and an indicator of the amount of competition among them. Therefore the use of HHI index in order to demonstrate the common practice is reasonable and appropriate in context of methodology in view of assessment team.		
Date of acceptance ~~or non expectance~~	Date: 20/02/2014	Status: Closed.

3 ASSESSMENT FINDINGS

Refer above section.

3.1 Relationship to Approved or Pending Methodologies

None of the existing approved VCS and CDM methodologies provide methods for accounting the emission reductions from trip avoidance due to carpooling. This methodology is new and has no relation with any of the approved methodologies in VCS and CDM. The pending methodologies as described in the proposed mythology have no direct relationship with the proposed methodology and by reviewing the below listed methodologies it was concluded that none of the methodology can be revised for accounting the GHG emission reductions for the the objective of the proposed new methodology.

Pending Methodologies:

Methodology	Title	GHG Program	Remark
(Pending)	Methodology for Determining GHG Emission Reductions Through Bicycle Sharing Projects	VCS	This methodology is developed for the bicycle sharing

			therefore has no direct relationship with the proposed methodology.
VM0019	Fuel Switch from Gasoline to Ethanol in Flex-Fuel Vehicle Fleets, v1.0	VCS	This is a fuel switch methodology therefore cannot replace the proposed methodology.
VM0020	Transport Energy Efficiency from Lightweight Pallets	VCS	This is an energy efficiency methodology therefore cannot be used for accounting the emission reductions for the car pooling.
VMR0004	Revisions to AMS-III.BC to Include Mobile Machinery, v1.0	VCS	Cannot be used for carpooling.
(NM0364, Pending)	Rail Methodology	CDM	This methodology is developed for the rail transport therefore cannot be revised for the car pooling.
ACM0016	Mass Rapid Transit Projects --- Version 3.0.0	CDM	The baseline and project activities to be included under this methodology are different to the proposed new methodology. Therefore this methodology cannot be revised to replace the proposed methodology.
AM0031	Bus rapid transit projects --- Version 5.0.0	CDM	Refer above comment.
AM0090	Modal shift in transportation of cargo from road transportation to water or rail transportation --- Version 1.1.0	CDM	This methodology is approved and applicable for the change in the mode of transportation therefore cannot be revised or applied for the car pooling as the proposed methodology.
AM0101	High speed passenger rail systems --- Version 1.0.0	CDM	This methodology relates to the rail transpiration therefore cannot be revised for car pooling.
AM0110	Modal shift in transportation of liquid fuels --- Version 1.0.0	CDM	This methodology pertains to the model shift therefore cannot be revised for car pooling.

AMS-III.AA.	Transportation Energy Efficiency Activities using Retrofit Technologies --- Version 1.0	CDM	This methodology is developed for the energy efficiency by retrofitting therefore can not be used for the car pooling as the baseline and project activities are different from the proposed new methodology.
AMS-III.AK.	Biodiesel production and use for transport applications --- Version 1.0	CDM	Cannot be revised due to different baseline and project activity scenario.
AMS-III.AP.	Transport energy efficiency activities using post - fit Idling Stop device --- Version 2.0	CDM	Cannot be revised due to different baseline and project activity scenario.
AMS-III.AQ.	Introduction of Bio-CNG in transportation applications --- Version 1.0	CDM	Cannot be revised due to different baseline and project activity scenario.
AMS-III.AT.	Transportation energy efficiency activities installing digital tachograph systems to commercial freight transport fleets --- Version 2.0	CDM	This methodology is developed for the energy efficiency by retrofitting therefore cannot be used for the car pooling as the baseline and project activities are different from the proposed new methodology.
AMS-III.AY.	Introduction of LNG buses to existing and new bus routes --- Version 1.0	CDM	This methodology is developed/approved for fuel switch therefore cannot be used for the car pooling as the baseline and project activities are different from the proposed new methodology.
AMS-III.BC.	Emission reductions through improved efficiency of vehicle fleets --- Version 1.0	CDM	This methodology is developed for the energy efficiency by retrofitting therefore cannot be used for the car pooling as the baseline and project activities are different from the proposed new methodology.
AMS-III.C.	Emission reductions by electric and hybrid vehicles --- Version 13.0	CDM	This methodology is developed for the fuel

			switch therefore cannot be used for the car pooling as the baseline and project activities are different from the proposed new methodology.
AMS-III.S.	Introduction of low-emission vehicles/technologies to commercial vehicle fleets --- Version 4.0	CDM	This methodology is developed for the fuel switch therefore cannot be used for the car pooling as the baseline and project activities are different from the proposed new methodology.
AMS-III.T.	Plant oil production and use for transport applications --- Version 2.0	CDM	Cannot be revised due to different baseline and project activity scenario.
AMS-III.U.	Cable Cars for Mass Rapid Transit System (MRTS) --- Version 1.0	CDM	Cannot be revised due to different baseline and project activity scenario.

3.2 Stakeholder Comments

The methodology was available for the public comment for the duration of 24 October 2013 until 23 November 2013; only one comment was received during the period. The comment was submitted to methodology developer in the form of finding (CL#06) and the response of methodology developer were assessed by the assessment team of KBS. Please refer to finding CL#06 mentioned in detail in the section 2.5 of the report.

3.3 Structure and Clarity of Methodology

The methodology is written in the clear, concise and precise manner viz:

- The recent template available on the VCS website is used to develop the methodology, the proposed methodology comply with the VCS VVM and “Methodology Approval Process.
- The terminologies used in the methodology are standard and consistent with the other GHG program.
- The equations used to account the GHG emission reductions are standard and can be understood and applied readily and consistently by the project proponents.

3.4 Definitions

The key terms used in the methodology are defined in the clearly and appropriately and are consistently used in the methodology. All the key acronyms are listed in the definition section of the proposed methodology and used consistently therein.

3.5 Applicability Conditions

Applicability Criteria	Validation Remark
• Each commuter carpool must take place within (one of) the carpool Community Area(s) defined in the project description. • The carpool Community Area(s) must be located in regions where vehicles with on-board diagnostic interface (OBDII) are commonplace. These regions include North America, Europe, Japan and Australia at the time of publication.	• The applicability criteria mentioned for the commuter in order to participate in the project activities applying the proposed methodology in a defined carpool Community Area(s) is reasonable and would lead to the accurate quantification of GHG emission reduction. • The relation between the locations of carpool Community Area(s) and availability of OBDII is logical and correctly included by the methodology developer in context of methodology. The same was confirmed from the consultation of technical area expert.
• All carpool vehicles must support OBDII interface.	• This eligibility criteria is essential to apply the methodology and one of the prerequisite as there is no reasoning of applying the methodology without the availability of OBDII interface.
• Each carpool member must register with the CMMS and be uniquely identified via smart phone identity (MEI and/or phone number) • Each carpool member must own a private vehicle that is available for commute and register that vehicle with the CMMS. • Each carpool member must carry their smartphone and run CMA on all carpool trips for emission	• The registration of each carpool member with the CMMS will lead to the unique identity of each commuter and therefore will lead to accurate monitoring of ex-post emission reductions. • The requirement of mandatory ownership of private car to each carpool member and its registration with CMMS will avoid any over or underestimation of ex-post GHG emission reductions.

reductions from such trips to be included in the quantification of emission reductions The methodology is not applicable under the following condition: • A carpool member for whom baseline transport mode (as describe later) is not a carpool or drive alone. • A carpool trip where the carpool vehicle's monitoring system is not functioning properly (eg, has the check engine light on) or the carpool vehicle does not have the OBDII dongle attached to its OBD port is not eligible to be included in the quantification of emission reductions.	• The mandatory requirement of smart phone with every carpool member and run CMA with every carpool trip will lead the actual monitoring and therefore the appropriate accounting of GHG emission reductions. • The methodology developer has also described the non applicability of methodology correctly as their non availability will not lead to the correct quantification of GHG emission reductions.

3.6 Project Boundary

The project boundary covers under this methodology is the boundary in which the vehicles members make all carpool trips, for which parameters are collected from members' smart phones by the CMA for the CS. A single project will be defined according to the carpool Community Area of coverage and the participating carpool members. One project may group various Community Areas and their carpool members. All carpool members do not necessarily have to be identified specifically at the time of project description. A project could be defined, for example, as "the first 10,000 members in the Boston metro area" or "employees of Company X in the San Francisco Bay area, Atlanta metro area, and Boston metro area". Key data for calculating the baseline and project emissions will be centrally managed and stored by the Project Proponent.

For projects under this methodology, the primary emissions effects considered are (1) reduction in GHG emissions from burning of fossil fuels by cars taking part in single occupancy trips, and (2) reduction in indirect GHG emissions from the off-site generation of electricity from electric-powered cars taking part in single occupancy trips. The latter emissions source is only eligible in Community Areas for which the GHG emissions from the electricity supply are not regulated[1].

The methodology also assesses the indirect GHG emissions from the off-site generation of electricity for powering the central carpool server as leakage emissions. The emissions boundary

[1] In this case electricity generation GHG Emission factor (EF_p) corresponding to project geographic area p can be set to zero when calculating baseline emission

does not include the CSs, since they may or may not be owned and operated by the project proponent.

The emissions boundary does not include the smart phones running the CMA, since running the project application is not the primary driver of smart phone use by carpool members.

The assessment team concludes that the project boundary provides in the proposed methodology covers the entire area where the carpool commuters would travel.

Table 2: GHG Sources Included in or Excluded from the Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Fossil fuel emissions from FFVs and/or PHEVs used in SOBTs	CO_2	Yes	Main emission source in the combustion of fossil fuel and electricity generation.
		CH_4	No	Minor source excluded for simplification; this is conservative
		N_2O	No	Minor source excluded for simplification; this is conservative
		Other	No	Not applicable
	Indirect fossil fuel emissions from electricity generation used for PHEVs and/or PEVs used in SOBTs	CO_2	Yes	Main emission source in the combustion of fossil fuel.
		CH_4	No	Minor source excluded for simplification; this is conservative
		N_2O	No	Minor source excluded for simplification; this is conservative
		Other	No	Not applicable
Project	Fossil fuel emissions from FFVs and/or PHEVs used in carpool trips	CO_2	Yes	Main emission source in the combustion of fossil fuel and electricity generation.
		CH_4	No	Minor source excluded for simplification.
		N_2O	No	Minor source excluded for simplification.
		Other	No	Not applicable
	Indirect fossil fuel emissions from electricity generation used for PHEVs and/or PEVs used in carpool trips	CO_2	Yes	Main emission source in the combustion of fossil fuel for electricity generation.
		CH_4	No	Minor source excluded for simplification.
		N_2O	No	Minor source excluded for

Source		Gas	Included?	Justification/Explanation
				simplification.
		Other	No	Not applicable

CO_2 is the only gas which would have been released in the atmosphere due the usage of fossil fuel in the baseline as well as in the project activity scenario. The methodology developer has correctly identified the same in the updated version of methodology. On the other hand the usage of electricity in the project scenario will also resulted in the CO_2 emission in the atmosphere. The assessment team concludes that CO_2 is the only GHG which needs to be accounted the calculation of baseline and project emissions in the project boundary and the gases under the project boundary are correctly identified by the methodology developer.

3.7 Baseline Scenario

The methodology developer has identified the following alternatives in order to choose the most plausible baseline scenario;

The available alternatives to the carpool commuters are identified as:

1. Driver alone
2. Carpool (project activity)
3. Alternative transport mode – public transit, walking, bicycling, motorcycle
4. Work from home

In order to pick the most plausible baseline scenario the following information would be mandatory in order to apply the methodology:

At the time of registration with the carpool program following information:

At the time of registration with the carpool program, member provides information about commuting modes used in past 12 months projecting current work and resident address for last 12 month for spring, summer, fall and winter months (June-Aug, Sept-Nov, Dec-Feb, March-May):

   a. On average, number of (fractional) days per week drive alone to work
   b. On average, number of (fractional) days per week carpooled to work
   c. On average, number of (fractional) days per week used alternative transport mode – public transit, taxicab, walking, bicycling and motorcycle – to work.
   d. On average, number of (fractional) days per week worked from home

2. Register, confirm biennially and keep up-to date SOBT vehicle.
3. Register, confirm biennially and keep up to date resident and work address.

The CMMS determines baseline transport mode for a carpool member as follows by applying the below equations:

1. Determine PCC & BEQC for the carpool member as follows:

$$PCC_i = \frac{\sum_m C_{i,m}}{20} \quad (1)$$

$$BEQC_i = \frac{\sum_m S_{i,m}}{20} \quad (2)$$

Where:

m : Season identifier – spring, summer, fall & winter

i : Individual carpool member identifier

$S_{i,m}$: Number of days a carpool member i drive alone during seasons m

$C_{i,m}$: Number of days a carpool member i carpool during seasons m

PCC_i : Pre-program carpooling co-efficient of a carpool member i

$BEQC_i$: Baseline Emission quantification co-efficient of a carpool member i

2. If alternative transport mode is available and travel time with alternative transport mode is no more than 15 minutes longer compared to drive alone as determined using mapping software like Google MAP, the member baseline transport mode is alternative transport mode. (These members are not expected to switch their commute mode to carpool because of the project activity)
3. If carpool member doesn't register SOBT vehicle or doesn't own one, the member baseline transport mode is assumed to be alternative transport mode.
4. If member's BEQC is less than 0.2, than member's baseline transport mode is set to work from home.
5. If member's BEQC is greater than PCC, than member's baseline transport mode is drive-alone
6. If member's PCC is greater than or equal to BEQC, than member's baseline transport mode is carpooling.

The assessment team concludes based on its sectoral expertise:

- That the list of alternatives is complete, accurate and having an analogy with the GENERAL GUIDELINES FOR SSC CDM METHODOLOGIES in view of sectoral expert in the assessment team,
- The selection of most plausible baseline selection criterion as provided above is reasonable and will lead to the correct accounting of GHG emission reductions.

3.8 Additionality

As described in the proposed methodology, the following criteria set forth for the additionality demonstration:

Step 1. Regulatory Surplus

The project proponent shall carry out a review of the relevant laws, statutes, policies or other regulatory frameworks governing commuting in the Community Area of the project activity. Carpooling shall not be mandated by any of these relevant laws. Laws, statutes, regulatory frameworks or policies implemented since 11 December 1997 that give comparative advantage to more emissions- intensive technologies or activities relative to less emissions-intensive technologies or activities shall not be taken into account.

If carpooling is not mandated by any of the relevant laws, statutes, policies or other regulatory frameworks, then proceed to Step 2.

The procedure is in line to the CDM General Guidelines for SSC Methodologies i.e. EB 69, Annex 27.

Step 2. Implementation Barriers

A project to promote carpooling may face a variety of barriers to its implementation. The project shall demonstrate reasonably the existence of one or more barriers that it faces and describe how VCUs can help to overcome the barrier. For example, the following barriers may be faced by a project to promote carpooling:

- Investment barrier – limited sources of revenue mean the project is not financially attractive
- Technological barrier – appropriate computer and/or smart phone applications do not exist to allow users to manage their carpools
- Institutional barrier – limited inherent interest in the project from individuals or companies due to low desirability of carpooling

If the project can demonstrate reasonably the existences of one or more barriers that it faces and describe how VCUs can help to overcome the barrier, then proceed to Step 3.

The following procedure may be used by the project to demonstrate technological and/or institutional barriers mitigated by the project:

1. Technology to simplify carpool formation (eg, providing matching between rider and driver).
2. Activities to encourage carpooling among commuters (eg, employer providing special parking spot for the carpool vehicle).

The following procedure may be used by the project to demonstrate technological and/or institutional barriers mitigated by the project:

1. If baseline transportation mode of a carpool member is alternative transport mode or work from home, than member's activity is not additional.
2. If baseline transportation mode of a carpool member is carpool which is also a fampool, than member's activity is not additional.
3. If baseline transportation mode of a carpool member is carpool and PCC of the member is greater than or equal to 0.8, member's activity is not additional.

4. Member must (self) certify during registration process that carpool management and monitoring system (CMMS) removed technology/institutional barrier by providing atleast one of the following to enable him/her to do carpooling:
    a. Find another carpool member
    b. Track carpooling activity on member's behalf for the benefit of the member
    c. As a passenger, removed concerned about ride back home in some way.
    d. Incentives carpooling behaviour (by tracking carpool cost, facilitating automatic financial transaction between carpool member accounts, etc).

The step 2 is in compliance to the CDM additionality guideline for the SSC project activities i.e. vide para 1 of EB 68, Annex 27. The identification of alternative and the selection of most plausible baseline and thereafter their rank wise elimination as described in the details of baseline section of methodology is also in compliance to the CDM General Guidelines for SSSC Methodologies i.e. EB 69, Annex 27. The methodology developer has identified all the possible alternatives of project activity and assessed their impact on the additionality determination. Assessment team concludes that

Step 3. Common Practice

The following steps shall be used to demonstrate that the project activity is not common practice:

1) Demonstrate that within a community area there are commuting modes that are dominant.
2) Demonstrate that within a community area carpool commuting mode is not a dominant mode.

Herfindahl index (HHI)[2] used in economics to measure market competitiveness may be used to determine whether the market (potential commuting modes within the community area) is an oligopoly or monopoly market dominated by one or two firms (commuting modes). An HHI value of 2500 or higher indicates the market is dominated by fewer firms (modes).

$$HHI = \sum M_k^2 \qquad (3)$$

Where:

M_k : Percentage market share of firm (commuter mode) k (%)

For a community area located within the US, online tools on the US census website[3] may be used to demonstrate that the carpool commuting mode is not common practice.

For example, using the online tool on the US census website and data from the *2012 American Community Survey 1-year Estimate, for New York-Northern New Jersey-Long Island*, in the NY-NJ-PA Metro Area commuting modes and their usage results in HHI of 3546 indicating there are commuting modes (Driving alone 49.8 percent and public transit 31 percent) that dominate

2 Wikipedia
3 US Census online tool

commuter choice (step 1). Carpooling is used by 6.7 percent of the commuters thus meeting the threshold for carpooling to be considered not common practice (step 2).

	New York-Northern New Jersey-Long Island, NY-NJ-PA Metro Area	
	Estimate	Margin of Error
Total:	8,822,701	+/-28,922
Car, truck, or van:	4,989,077	+/-32,665
Drove alone	4,394,811	+/-30,999
Carpooled:	594,266	+/-16,108
In 2-person carpool	440,494	+/-14,236
In 3-person carpool	82,577	+/-5,349
In 4-or-more-person carpool	71,195	+/-5,307
Public transportation (excluding taxicab)	2,739,141	+/-22,580
Walked	538,986	+/-13,357
Taxicab, motorcycle, bicycle, or other means	191,038	+/-8,080
Worked at home	364,459	+/-9,627

$$HHI_{ay} = \sum 49.8^2 + 31^2 + 6.74^2 + 6.11^2 + 4.13^2 + .9^2 + .63^2 + .57^2 + .06^2 = 3546 \quad (4)$$

If the project proponent can demonstrate in this way that multiple-occupancy travel for commuting is not common practice in the project location, then the project is additional.

The assessment team concludes that the procedure determined for the additionality test in the proposed methodology is in line to the CDM additionality tool. The step wise approach to demonstrate additionality in the methodology has an analogy with CDM additionality tool for large scale project and SSC projects. The common practice analysis is also reasonable in the context of methodology and the calculation/demonstration of HHI value is reasonable in view of the financial expert. The financial expert in the assessment team also convinced with the threshold value of 0.25 for the determination of HHI index as it is very standard in economics.

3.9 Quantification of GHG Emission Reductions and Removals

3.9.1 Baseline Emissions

The following equations would be used to account the baseline emission reductions:

$$BE_y^i = \left(\left(D^i - \min\left(D^i, r_y^i \cdot \right) \right) \cdot \vartheta_y^i \right) \cdot EF_{y(i)} + \min\left(D^i, r_y^i\right) \cdot W_i \cdot GE_p \quad (5)$$

$$\vartheta_c^i = \begin{cases} V_c & g_V(c) = 0 \\ \hat{V}_c & g_V(c) = 1 \end{cases} \quad (6)$$

$$r_c^i = \begin{cases} 0 & \tau(c) = FFV \\ D^i & \tau(c) = PEV \\ R_c & \tau(c) = PHEV \end{cases} \quad (7)$$

Where:

i : Individual person identifier who travelled in carpool t_y.

D^i : Single Occupancy Baseline Trip (SOBT) Distance in kilometres for person i in absence of carpool trip

ϑ_c^i : Estimated fossil fuel efficiency of SOBT vehicle c registered to carpool member i

r_c^i : Estimated all electric range of SOBT vehicle c registered to carpool member i

BE_c^i : SOBT base-line emission for SOBT trip taken by member i in vehicle c in absence of carpool trip t_y.

$\hat{V}_c$: Measured average fossil fuel efficiency in l/km of vehicle identified by VIN number c

V_c : Vehicle fossil fuel efficiency in litres per kilometre (l/km) for vehicle identified by VIN number c, derived from manufacturer and/or government published fuel economy statistics.

R_c : Vehicle all electric range in kilometres for vehicle identified by VIN number c, derived from manufacturer and/or government published fuel economy statistics.

$EF_{f(c)}$: GHG Emission factor of fuel used by vehicle identified by VIN number c, measured as CO_2 tons per unit fuel volume. (Unit: tCO_2 /litre)

W_c : Vehicle electric efficiency in Kilo-Watt-hour per kilometre for vehicle identified by VIN number c, derived from manufacturer and/or government published fuel economy statistics.

GE_p : Electricity generation GHG Emission factor corresponding to project geographic area p measured as CO_2 tons per KWh, adjusted for transmission loss if any (Unit: tCO_2 /KWh)

$g_V(c)$: Indicator function for fossil fuel consumption measurement over OBDII interface enabled for vehicle identified by VIN number c

The equation (2) is a compact form combining all vehicle and indicator function types. The equation simplifies to the following when vehicle and indicator function types are identified separately as follows:

$$BE_c^i = \begin{cases} D^i \cdot W_c \cdot GE_p & \tau(c) = PEV \\ D^i \cdot V_c \cdot EF_{f(c)} & \tau(c) = FFV,\ g_V(c) = 0 \\ D^i \cdot \hat{V}_c \cdot EF_{f(c)} & \tau(c) = FFV,\ g_V(c) = 1 \\ max(0, D^i - R_c) \cdot V_c \cdot EF_{f(c)} + min(D^i, R_c) \cdot W_c \cdot GE_p & \tau(c) = PHEV,\ g_V(c) = 0 \\ max(0, D^i - R_c) \cdot \hat{V}_c \cdot EF_{f(c)} + min(D^i, R_c) \cdot W_c \cdot GE_p & \tau(c) = PHEV,\ g_V(c) = 1 \end{cases} \quad (8)$$

Note that SOBT vehicle VIN number i is obtained from the registration information of the member with identifier i.

If measured values of vehicle fossil fuel efficiency and/or electric efficiency values from past trips is available, average of last 3 month measured values is used as Measured average fossil fuel and electric efficiency to accurately account for SOBT vehicle emission. As specified in the equations above, if such measured values are not available, vehicle's government/manufacturer published fuel economy statistic is used.

3.9.2 Single Occupancy Baseline Trip Distance:

The Single Occupancy Baseline Trip (SOBT) route and distance is determined as one of the following, in the same order of preference:

1) Shortest time-route distance between the member origin and destination location as provided by Google or similar provider.
2) Shortest distance route distance between the member origin and destination location.

3.9.3 Baseline emissions for a carpool trip:

The baseline emissions for a carpool trip are estimated as the summation of individual SOBT trip emissions as is given as follows:

$$BE_{t_y} = \sum_{i \in N_{t_y}} BE_i^{'} \qquad (9)$$

Where:

N_{t_y} : Membership set of a carpool associated with the carpool trip t_y.

3.9.4 Baseline emissions for year y:

Baseline emissions for year y are calculated by summing baseline SOBT emissions of all carpool trips taken in year y.

$$BE_y = \sum_{t_y \in T_y} BE_{t_y} \qquad (10)$$

The assessment team evaluated all the above equations in the proposed methodology to derive the baseline emission reductions and concluded that the equations are comprehensive to account all the baseline emission reductions.

The assessment team confirms that:

1) The procedures for calculating baseline emissions and removals *cover* all GHG sources, and included in the above mentioned equations adequately.

2) All algorithms, equations and formulas used are appropriate and without error.

3) All models or default factors used are appropriate and in conformance with VCS requirements on same.

4) The procedures for estimating parameters related to the quantification of baseline emissions (e.g., the procedures for model selection) are appropriate.

3.9.5 Project Emissions

The project emission is calculated from monitored emissions from each carpool trip.

3.9.6 Project Carpool Trip Emission:

Project emissions for specific carpool trip t_y in year y is obtained by summing emissions from all carpool sub-trips.

3.9.6.1 Project emission for carpool sub-trip:

Each carpool sub-trip emission (PE_c^j) is estimated as the summation of emissions from burning fossil fuel in carpool vehicles' ICE and emissions at the electricity sources for spent electrical energy in carpool vehicles:

$$PE_c^j = \left(\left(d^j - \min\left(d^j, \phi_c^j\right)\right) \cdot \vartheta_c^j\right) \cdot EF_{f(c)} + \min\left(d^j, \phi_c^j\right) \cdot W_c \cdot CE_p \quad (11)$$

Where:

j : Particular carpool sub-trip numerical identifier, assigned in a way so that this sub-trip identifier is greater than that of all sub-trips occurred before this sub-trip within this carpool

c : Vehicle identifier number (ie, VIN number) of vehicle used in carpool sub-trip j

ϑ_c^j : Vehicle fossil fuel efficiency for carpool sub-trip j vehicle identified by VIN number c (Unit: l/km)

ϕ_c^j : Vehicle all electric range for carpool sub-trip j vehicle identified by VIN number c (Unit: km)

d^j : CMA measured travel distance of carpool sub-trip j. Distance is calculated using GPS and MAP feature of smartphone the CMA is running on. (Unit: km)

W_c : Vehicle electric efficiency in Kilo-Watt-hour per kilometre for vehicle identified by VIN number c, derived from manufactures and/or government publish fuel economy statistics.

$EF_{f(c)}$: GHG Emission factor of fuel used by vehicle identified by VIN number c, measured as CO_2 tons per litre. (Unit: tCO_2/litre)

GE_p : Electricity generation GHG Emission factor corresponding to project geographic area p measured as CO_2 tons per KWh, adjusted for transmission loss if any (Unit: tCO_2 /KWh)

PE_c^j : Project emission for carpool sub-trip j in vehicle identified by VIN number c. (Unit: tCO_2)

Accurate sub-trip vehicle fossil fuel efficiency, all electric range (PEVs/PHEVs), and electric efficiency (PEVs/PHEVs) can be obtained by on-demand reading of actual fuel consumption over OBDII interface when available and implemented in CMA[4]. This is the preferred source of these monitoring parameters. When such measurement is not available, government/manufacturer published fuel economy statistics are used. If project vehicle fossil fuel efficiency is obtained using government/manufacturer published fuel economy statistics, corresponding baseline vehicle fossil fuel efficiency must be determined using government/manufacturer published fuel economy statics for that carpool trip, even when fossil fuel efficiency based on actual fuel consumption via OBDII interface is available.

Vehicle all-electric range for the carpool sub-trip j is determined as follows:

$$e_c^j = \begin{cases} 0 & \tau(c) = FFV \\ d^j & \tau(c) = PEV \\ \max(0, R_c - cd_c^j) & \tau(c) = PHEV \end{cases} \quad (12)$$

Where:

cd_c^j : Cumulative distance travelled by vehicle c before sub-trip j within carpool trip t_y.

R_c : Vehicle all electric range in kilometres for vehicle identified by VIN number c, derived from manufactures and/or government publish fuel economy statistics.

$\tau(c)$: Type of vehicle identified by VIN number c. (i.e, FFV, PEV or $PHEV$)

Cumulative distance travelled by vehicle c before sub-trip j is determined as follows:

$$cd_c^j = \sum_{\{j \mid s_{t_y,c}(j)=c, j<j\}} d^j \quad (13)$$

Where,

$C(j)$: VIN number of vehicle used in sub-trip j

Vehicle fossil fuel efficiency for carpool sub-trip j vehicle identified by VIN number c is determined as follows:

[4] See reference [5]

$$\theta_c^j = \begin{cases} \dfrac{V_c}{FC_c^j} & g_V(\sigma) = 0 \\ \dfrac{}{\left(d^j - \min\left(d^j, R_c^j\right)\right)} & g_V(\sigma) = 1 \end{cases} \qquad (14)$$

Where:

FC_c^j : Fuel consumption measured in liters (or cubic feet for natural gas) over OBDII interface supported by manufacturer of the vehicle during carpool sub-trip j for vehicle identified by VIN number c.

V_c : Vehicle fossil fuel efficiency in litres per kilometre (l/km) for vehicle identified by VIN number c, derived from manufactures and/or government publish fuel economy statistic.

$g_V(\sigma)$: Indicator function for fossil fuel consumption measurement over OBDII interface enabled for vehicle identified by VIN number c

The equation **(11)** is a compact form combining all vehicle types and indicator function states. The equation simplifies to the following when vehicle type is identified separately:

$$PE_c^j = \begin{cases} d^j \cdot W_c \cdot GE_p & \tau(\sigma) = PEV \\ d^j \cdot V_c \cdot EF_{f(c)} & \tau(\sigma) = FFV,\ g_V(\sigma) = 0 \\ FC_c^j \cdot EF_{f(c)} & \tau(\sigma) = FFV,\ g_V(\sigma) = 1 \\ FC_c^j \cdot EF_{f(c)} + \min\left(d^j, \max\left(0, R_c - dd_{\xi}^j\right)\right) \cdot W_c \cdot GE_p & \tau(\sigma) = PHEV,\ g_V(\sigma) = 1 \\ \left(\left(d^j - \min\left(d^j, \max\left(0, R_c - dd_{\xi}^j\right)\right)\right) \cdot V_c\right) \cdot EF_{f(c)} & \\ \quad + \min\left(d^j, \max\left(0, R_c - dd_{\xi}^j\right)\right) \cdot W_c \cdot GE_p & \tau(\sigma) = PHEV,\ g_V(\sigma) = 0 \end{cases} \qquad (15)$$

3.9.7 Project emissions for carpool trip

Carpool trip emissions (PE_{t_y}) are calculated as follows:

$$PE_{t_y} = \sum_{j \in t_y} PE_c^j \qquad (16)$$

Project emission for year y

Summation overall carpool trips in year y provides project emission for year y (PE_y).

$$PE_y = \sum_{t_y = T_y} PE_{t_y} \qquad (17)$$

The assessment team confirms that:

- The procedures for calculating project emissions *included* adequately *in the project boundary*

- All algorithms, equations and formulas used are appropriate and without error.
- All models or default factors used are appropriate and comply with the VCS rules on same.
- The procedures for estimating parameters related to the quantification of project emissions and removals are appropriate.

3.9.8 Leakage

Leakage emissions are calculated for the off-site generation of electricity for powering the central carpool server(s), which may or may not be owned and operated by the project proponent. Leakage emissions (LE_y) are calculated as follows:

$$LE_y = \sum EC_{cs} \cdot GE_{cs} \quad (18)$$

Where,

LE_y : Leakage emissions (Unit: tCO_2)

EC_{cs} : Electricity consumption by the central carpools server(s) (Unit: kWh)

GE_{cs} : Electricity generation GHG Emission factor relevant to the central carpool server(s) measured as CO_2 tons per KWh, adjusted for transmission loss if any. (Unit: tCO_2 /KWh)

Assessment team confirms that the leakage calculations as mentioned in the equation (16) is appropriate and cover all the emissions outside the project boundary.

3.9.9 Net GHG Emission Reductions and Removals

The net GHG emission reductions are quantified/accounted by using the following equation:

$$ER_y = BE_y - PE_y - LE_y \quad (19)$$

Where:

ER_Y = Net GHG emissions reductions in year y

BE_Y = Baseline emissions in year y and the detail procedure is defined in above sections.

PE_y = Project emissions in year y and the detail procedure is defined in above sections.

LE_y = Leakage in year y and the detail procedure is defined in above sections.

.

3.10 Monitoring

3.10.1 Data and Parameters Available at Validation

Parameter	Remark
GE_p	Use equivalent emission calculator from EPA http://www.epa.gov/cleanenergy/energy-resources/refs.html The value for this parameter is to be sourced from the website of US EPA and this value is used to calculate the ex-post project emissions included in the project boundary. The value is available on the publicly and released by the government authority, therefore its reliability is authentic.
$EF_{f(c)}$	The value for this parameter is to be sourced from the website of US EPA and this value is used to calculate the ex-post baseline emissions. The value is available on the publicly and released by the government authority, therefore its reliability is authentic and is appropriate to use for the GHG accounting..
V_c	Government/manufacturer published fuel economy value is converted in liter per kilometer to match calculation units. If city/highway values are provided, average or either of two depending on road type (highway or city street) may be used. Data from authoritative source is preferred (eg, EPA in the USA). The data published by any government agencies are always authentic and can be assessed easily by the methodology users.
R_c	Government/manufacturer published fuel economy value is converted in kilometer to match calculation units. If city/highway values are provided, average or either of two depending on road type (highway or city street) may be used. Data from authentic source is preferred (eg, EPA in the USA) The data published by any government agencies are always authentic and can be assessed easily by the methodology users.
W_c	Manufacturer/Government published. In US, data available at http://www.fueleconomy.gov Government/manufacturer published fuel economy

	value is converted in KWh per kilometer to match calculation units. If city/highway values are provided, average or either of two depending on road type (highway or city street) may be used. Data from authoritative source is preferred (eg, EPA in the USA) The data published by any government agencies are always authentic and can be assessed easily by the methodology users.

The above mentioned data would be used ex-ante and to be made available at the time of applying the methodology. The assessment team has reviewed all the above mentioned parameters and found that the list of data is complete and reasonable to account the ex-ante emission reductions. The data sources are the data released by the government agencies, in USA the data released by the US EPA will be used to calculate the GHG emission reductions and if the methodology is applied other parts of world, the data published by the respective governments/other responsible authorities would be used.

3.11 Data and Parameters Monitored

The following data would be required to monitor to account the ex-post ERs.

Parameter	Remark
d^{j}	This monitoring parameters pertains to Distance travelled during sub-trip j. CMA running on each member takes GPS measurements at periodic interval and reports to CS as a part of trip report. The frequency of monitoring would be on every sub-trip. The crosschecks of this monitoring parameter are also appropriately described in the proposed methodology. The assessment team concludes the monitoring frequency; monitoring method and QA/QC procedures mentioned in the proposed methodology would lead to the accurate GHG reduction calculation.
$C(f)$	The monitoring parameter pertains to the VIN number of vehicle used for sub-trip j. CMA running on member's smart phone programmatically queries vehicle's ECU over OBDII interface for vehicle VIN. Queried at periodic interval and reported to CS as a part of trip report. At least one, authorized member CMA reports VIN number in every sub-trip. The frequency of monitoring would be on every

	sub-trip. The crosschecks of this monitoring parameter are also appropriately described in the proposed methodology. The assessment team concludes the monitoring frequency; monitoring method and QA/QC procedures mentioned in the proposed methodology would lead to the accurate GHG reduction calculation.
N^j	The monitoring parameter pertains to Set of members i carpooling together in sub-trip j. Element are meta-data (phone number or username). CMA running on member smartphone report wirelessly detected OBDII device Id attached to the vehicle in trip report. CS determines co-occupancy of members reporting same OBDII device Id within reasonable time-stamp. The assessment team concludes the monitoring frequency; monitoring method and QA/QC procedures mentioned in the proposed methodology are appropriately defined and would lead to the accurate GHG reduction calculation.
D^i	The monitoring parameter pertains to single-occupancy baseline trip distance of member i The source for this parameter would be mapping or navigational software (eg, Google maps or similar service provider) or member provided. The Shortest time distance based on source and destination addresses provide by member, not considering current traffic condition. If mapping software provides shortest time route based on average traffic delay, distance along such route is permissible. The monitoring frequency is once every six months and on demand when new source & destination address is known. The appropriate crosschecks are also defined for this monitoring parameter in the methodology. The assessment team concludes the monitoring frequency; monitoring method and QA/QC procedures mentioned in the proposed methodology are appropriately defined and would lead to the accurate GHG reduction calculation.

S_{t_y}	The monitoring of "set of sub-trips making up carpool trip t in year y". The monitoring would be carried out from the CMA running on member smartphone records GPS co-ordinate, detected OBDII device Id attached to the vehicle and corresponding time stamp at periodic interval for trip report. Upon receiving trip report, CS determines nature of trip as carpool multi-occupancy trip or carpool single-occupancy trip or not a carpool trip. The assessment team concludes the monitoring frequency; monitoring method and QA/QC procedures mentioned in the proposed methodology are appropriately defined and would lead to the accurate GHG reduction calculation.
i	The monitoring parameter pertains to,"CMMS assigned unique identifier for a member". The source for this monitoring parameter would be CMMS assigned unique identifier for a member identified by username/password and/or social media security-token (e.g. facebook) and/or phone number and/or smart phone MEI. This information is obtained during registration and stored in CMMS data based. The frequency is once at the time of registration, this is a onetime registration requirement and relates to the privacy of the commuter. The parameter is appropriately defined in the monitoring plan and will register the unique identity of each member participating in the car pool. The assessment team concludes the monitoring frequency; monitoring method and other procedures mentioned in the proposed methodology for the monitoring parameter are appropriately defined and would lead to the accurate GHG reduction calculation.
$S(i)$	VIN number of register SOBT vehicle to member i would be sourced during member registration process if member owns a private vehicle SOBT vehicle a private VIN number is assigned for that SOBT vehicle based on vehicle registration number (ie, vehicle tag plate/license plate) and/or year, make, model and/or trim entered by the member. Private VIN may be updated if member uses the

	same vehicle for carpooling and actual vehicle VIN is reported by CMA. If member doesn't own a private SOBT vehicle, hypothetical SOBT vehicle with national/regional average vehicle efficiencies is assigned for the member and a private VIN is create to tracked that hypothetical vehicle. The assessment team concludes the monitoring frequency; monitoring method and QA/QC procedures mentioned in the proposed methodology are appropriately defined and would lead to the accurate GHG reduction calculation.
EC_{CS}	The monitoring parameter pertains to, "Electricity consumption by the central carpools server(s)" Source: When the CS is owned and operated by the project proponent: The electricity consumption of the CS is either measured using e.g an electricity meter, or estimated based on the rated power of the CS and its operating hours When the CS is not owned and operated by the project proponent (ie, is deployed in public or private cloud), then the kWh attributable to the project are estimated based on the server usage (or allocated server sizing) information in the invoices from the external CS service provider. Example: http://aws.amazon.com/ec2/pricing/ This parameter is to be used in the ex-post leakage calculation and its value in comparison to baseline emission would be very lesser due to the minimum electricity consumption of CS based on the sectoral expertise of assessment team. The assessment team concludes the monitoring frequency; monitoring method and QA/QC procedures mentioned in the proposed methodology are appropriately defined and would lead to the accurate GHG reduction calculation.
FC_{c}^{j}	Fossil fuel consumption for sub-trip j in vehicle c will be sourced from CMA running on member's smart phone programmatically queries vehicle's ECU over OBDII interface for various fuel cycle parameters to monitor fossil fuel consumption. The frequency of monitoring would be every

	carpool sub-trip and this parameter would Not applicable to PEV vehicles. A carpool trip is consisting of associated sub-trip reports from one or more CMA. Examine authorized CMA reports to obtain fuel consumption when implemented. This parameter is only available if supported by CMA, smartphone and vehicle ECU. The parameter will be used to compute the ex-post project emission calculation, assessment team concludes the monitoring frequency; monitoring method and QA/QC procedures mentioned in the proposed methodology are appropriately defined and would lead to the accurate GHG reduction calculation.
V_c	Measured average fossil fuel efficiency of vehicle c will be computed from average of values collected for all trips during past 3 months. This is a calculated parameter based on the other monitoring parameters as described in above section. The frequency is mentioned as every trip appropriately. No QA/QC required for this parameter being a calculated one.

KBS confirms that each data/parameter monitored as assessed above, is appropriate with respect to data unit, source of data, description of measurement methods and procedures to be applied, frequency of monitoring/recording, QA/QC procedures to be applied, purpose of data, and calculation method.
Hence the values applied for calculation will real, measurable, conservative and transparent which is in line with VCS guideline. The monitoring parameter list is complete and will lead to quantify the ex-post emission reductions.

Apart the monitoring of above mentioned parameters, the methodology also prescribes to follow the following monitoring plan while using the proposed methodology for the car pooling:

> Each carpool member participating in the project must register with the carpool server (CS) and provide information as follows:
>
> 1) Upload personal Identifying information (eg, name, address, phone number, etc)
> 2) Upload one or more single-occupancy trip (SOBT) details (which alternatively could be auto-learned without explicit participant input, and/or auto-verified without explicit participant input):
>   a. End-points (ie, home & work addresses or home & destination cities)
>   b. Vehicle Id (ie, vehicle VIN number)

c. A carpool vehicle if that vehicle is only used for carpool. Example – employer provided or arranged vans for vanpool

3) Download carpool monitoring application (CMA) on their smartphone

4) Place on-board diagnostic version 2 (OBDII) interface device in the carpool vehicle and if applicable on SOBT vehicle

CMA running on a carpool member's smartphone must perform the following operations:

1) Detect and record identity of OBDII device in the vehicle. Medium Access Address (MAC address) uniquely identifies each OBDII device (other temper proof ids can also be used)

2) Calculate and record time, distance and trip endpoints using smartphone GPS function.

3) When authorized, establish wireless link to OBDII device and query and records vehicle VIN number

4) May also estimate and record fuel consumption along trip endpoints by reading fuel cycle parameters from vehicle engine control unit (ECU) through OBDII device. Depending on available fuel cycle parameters, fuel consumption is estimated using most suitable method.

5) Create a trip report with above parameters and send it to the carpool server.

Upon receiving a trip report from two or more CMAs, the carpool server must establish the following:

1) Determine the carpool membership set

2) Estimate the carpool GHG emission based on carpool sub trips fuel consumption data reported by CMAs, and/or carpool sub trips distance plus vehicle VINs combined with EPA/manufacturer fuel efficiency. Vehicle VIN enables determination of vehicle EPA/manufactures estimated fossil fuel efficiency to estimate fuel consumption when OBDII based fuel consumption is not reliable or feasible. This is the fundamental block to estimate project emission.

3) Estimate the baseline emissions by assuming SOBT trips in absence of carpool trip, based on the membership set and their registered SOBTs.

All monitoring data for emission reduction calculations must be archived in a secure and retrievable manner for at least two years after the end of the project crediting period.

The assessment team has reviewed the entire monitoring plan as explained in the proposed methodology and found it complete and appropriate in context of applying it to real cases to calculate the ex-post ERs from the carpooling.

4 ASSESSMENT CONCLUSION

KBS completed the first assessment of the methodology 'GHG Emission Reductions Through Carpooling, version 1 dated 24th October 2013' and concludes that the methodology comply with the latest version of VCS Methodology Approval Process.

5 REPORT RECONCILIATION

The methodology revised/updated during the 2nd assessment by ICONTEC international, KBS team reviewed the revised methodology version and convinced with the changes made in the methodology simplified the methodology for the users are all the changes are appropriate. KBS supports all the changes made in the revised version of methodology version 2.1.

6 EVIDENCE OF FULFILMENT OF VVB ELIGIBILITY REQUIREMENTS

KBS Certification Services Private Ltd. (KBS) fulfils both the criteria as described in the para 4.1.1 of the "VCS Methodology Approval Process, version 5 as a first VVB for the methodology assessment.

1) KBS is eligible under the VCS Program to perform validation for the applicable sectoral scope(s),

&

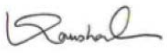
2) KBS successfully validated more than ten CDM project validations in the sectoral scope group applicable to the methodology element as per the ANSI (American National Standards Institute) in which the proposed methodology falls. The list of projects is publicly available on CDM website and can be viewed through the following web link:

   http://cdm.unfccc.int/Projects/projsearch.html

7 SIGNATURE

Signed for and on behalf of:

Name of entity: KBS Certification Services Private Limited (KBS)

Signature:  _____

Name of signatory: Mr. Kaushal Goyal

Date: 15/03/2015