CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

SECTION A. General description of project activity

A.1. Title of the Project Activity:

Recovery and Utilization of Associated Gas to Optimize Power Generation at PETROAMAZONAS Block 15 Facilities
Version 02.41, Date: 28 March 2011

A.2. Description of the Project Activity:

A 2.1 The purpose of the Project Activity

The purpose of the Project Activity is to utilize associated gas that was previously flared or would have been flared in the absence of the Project Activity at the Block 15 and Block 31 in Ecuador. The main reasons associated gas is flared is because: i) funds within oil companies are normally prioritized for drilling and crude processing facilities; ii) the unstable nature of associated gas presents significant challenges for power generation; and, iii) lack of infrastructure for gas handling / transportation.

The gas that would have been wasted in flares of the Block 15 and Block 31 represents an important energy source. For this Project Activity it is critical to take into consideration all the variables that jeopardize the stability and reliability of power supply with associated gas such as: crude oil production, water cut, Gas Oil Ratio (GOR), gas quality, stability and quantity. These variables are never 100% predictable or stable which poses significant challenges to using associated gas for power generation in an industry where 100% reliability on power supply is of vital importance. Changing the operational practices of an oil company inside an existing operation to endorse utilization of associated gas is highly challenging due to unconventional capital expenditure requirements, potential loss of crude oil production during project implementation and significant technical and operational barriers that need to be overcome for continuous use of associated gas for reliable power generation. Converting an unstable raw material (associated gas) into a stable product (electricity) is a challenging endeavor.

The proposed Project Activity is the first project in the oil industry in Ecuador to modify existing oil field facilities / infrastructure to enable the utilization of associated gas, even though the existing energy infrastructure on the oil field already meets power demands. Normally, associated gas utilization is either implemented as part of greenfield oil field projects or not at all.

Under the Project Activity GHG emission reductions will be achieved by gathering and processing the associated gas coming from Block 15 and Block 31 and subsequently treating and transporting the gas to gas power generating facilities suitable for associated gas. Apart from this it is necessary to put in place power distribution facilities to transport the power to the various end users.

In order to achieve the indicated goals, the following is included in the Project:

- Gas gathering facilities.
- Gas processing (compression and treatment) facilities.
- Power generation facilities (upgrade / new equipment).
- Convert engine drivers with electrical motors.
- Electric distribution systems (switchgear, substations, distribution lines, etc.).

A 2.2 How the proposed Project Activity reduces greenhouse gas emissions

The gas optimization project competes for funds with a variety of oil production and production facility projects in a situation where:

i. PETROAMAZONAS already has existing power generation facilities that provide the required power for the field.
ii. Flaring ("business as usual") is a feasible option, which requires no additional investment.
iii. Overcoming the technical hurdles to develop gas gathering and handling facilities requires new capital.

Thus, the baseline situation would be continued in the absence of possible income from CDM; the associated gas was flared or would have been flared, and liquid fossil fuel would have been used to generate electricity. In the Project Activity the utilized associated gas will displace liquid fossil fuels that are used in the existing power generation equipment which will lead to a reduction in greenhouse gases emissions.

A 2.3 Contribution to Sustainable Development

The Project Activity contributes to the sustainable development of Ecuador for the following reasons:

- Fuel switch from liquid fuel (either diesel or crude oil) to associated gas will significantly reduce SOx and NOx emissions, mitigating air pollution and its adverse impacts on human health.
- Gas-flaring reduction avoids the release of pollutants due to improper combustion of gas in the flare, which is evident from the smoke that is released from the flare. This subsequently contributes to increased hazardous chemicals, such as volatile organic compounds, released into the environment. Furthermore, and relevant to the Amazonian Region, the recovery and utilization of flare gas diminishes exposure of the endemic insects to the flaming heat, which attracts them specifically at night.
- A major share of power produced in PETROAMAZONAS´ facilities before the project implementation was generated with either diesel or crude oil. By substituting the electricity generated with liquid fossil fuel with electricity generated with associated gas, the proposed Project Activity will save approximately 25 million gallons of fossil fuel per year[1]. Part of the power generation will continue to be based on liquid fossil fuels even with the Project Activity due to: i) certain remote locations will not be interconnected to the new gas-based electricity infrastructure given lack of critical mass / economy of scale; and, ii) there is not enough associated gas available to generate 100% of the power demand with this fuel. The portion of power generated with liquid fossil fuels in a year varies according to the power demand and the availability (quantity and quality) of associated gas.
- The Ministry of Electricity and Renewable Energy estimates that almost 80% (see document "Strategic policies to change the energy matrix" [2]) of the associated gas in Ecuador is wasted. Gas flaring is common because: i) of a lack of incentives for associated gas utilization on a national level, ii) lack of initiative to reduce flaring by oil companies, iii) high investment cost related to gas utilization and iv) high level of uncertainty in terms of future quantity and quality of associated gas. The National Energy Policies (2008 – 2020) encourage (although no incentives are provided, nor has it made it mandatory) the sustainable use of non renewable energy resources. One focus area is that

[1] Please refer to the Investment Analysis calculation.

of optimizing flare gas to reduce the dependency of diesel for power generation[2]. The Project Activity can be a good example for other oil-producing companies to draw attention to the problem.

- The Ecuadorian Government sees the Project as a valuable example to promote energy efficiency and use of local energy sources in order to increase energy independency, in conjunction with which it also sees the CER income as a valuable source of co-financing for potential projects. The Project Activity's ground breaking initiative in contracting CERs has been acknowledged by the President of Ecuador and most senior members of the Cabinet.
- Finally, by utilizing associated gas for power generation, the Project Activity will contribute to promoting advanced environment-friendly technology in the oil industry in Ecuador and regionally in Latin-America, to entice other oil companies to replicate such investment programs in energy efficiency.

A.3. Project Participants:

Name of party involved	Private and/or public entity(ies)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Ecuador	PETROAMAZONAS EP	No
Republic of Finland	Wärtsilä Finland Oy	No
Sweden	Tricorona Carbon Asset Management Pte Ltd.	No

A.4. Technical Description of the Project Activity:

A.4.1. Location of the Project Activity:

The Project Activity is located within the oil fields known as the Block 15 and Block 31 operated by PETROAMAZONAS, which is in the Amazonian Region.

A.4.1.1. Host Party(ies):

Republic of Ecuador

A.4.1.2. Region/State/Province etc.:

Sucumbios and Orellana Provinces

A.4.1.3. City/Town/Community etc.:

Province	Town
Sucumbios	Shushufindi

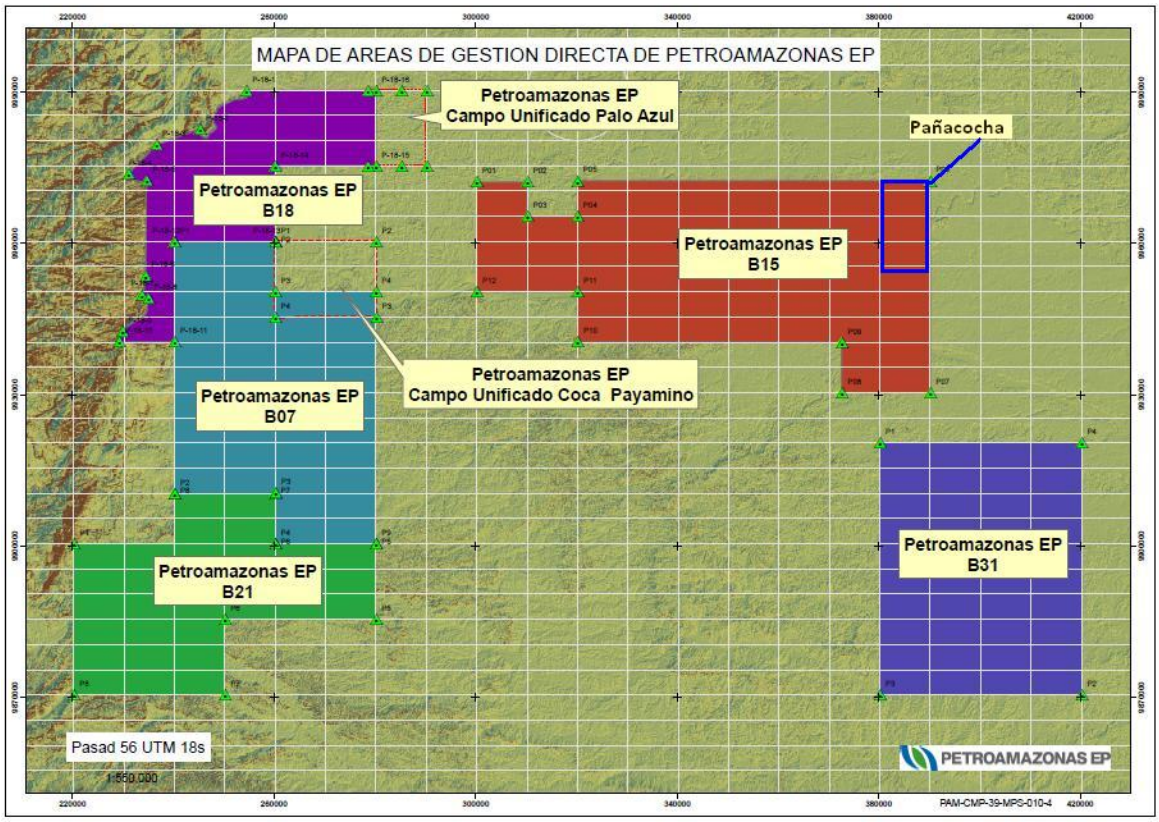
[2] Ministry of Electricity and Renewable Energy, "Strategic policies to change the energy matrix", May 2008.

	Lago Agrio
	Cuyabeno
Orellana	Orellana
	La Joya de los Sachas

Source: ENTRIX, "Internal environmental audit to current power generation systems at Indillana, Limoncocha and Yanaquincha and Eden Yuturi Field"

A.4.1.4. Details of physical location, including information allowing the unique identification of this Project Activity (maximum one page):

The Project oil reservoirs, fields and oil wells where the associated gas is collected (flared in absence of the Project Activity), as well as the gas recovery, consisting of gas transportation, treatment and processing infrastructure, are located in the Block 15 and Block 31. Please refer to the "Map of Areas of Direct Control of Petroamazonas".



Please find below the table with GPS coordinates for the Block 15 and the Block 31:

#	Latitude	Longitude
Block 15		
P01	0° 15' 4.390" S	76° 47' 41.843" W
P02	0° 15' 4.433" S	76° 42' 18.481" W
P03	0° 18' 45.221" S	76° 42' 18.765" W

P04	0° 18' 45.273" S	76° 36' 55.386" W
P05	0° 14' 57.374" S	76° 36' 55.355" W
P06	0° 14' 57.599" S	75° 59' 11.362" W
P07	0° 37' 45.330" S	75° 59' 11.341" W
P08	0° 37' 45.209" S	76° 8' 39.808" W
P09	0° 32' 19.889" S	76° 8' 39.743" W
P10	0° 32' 19.193" S	76° 36' 55.356" W
P11	0° 26' 53.627" S	76° 36' 55.278" W
P12	0° 26' 53.472" S	76° 47' 42.029" W
Block 31		
P1	0° 43' 10.790" S	76° 4' 34.890" W
P2	1° 10' 19.529" S	75° 43' 1.243" W
P3	1° 10' 19.112" S	76° 4' 35.391" W
P4	0° 43' 11.163" S	75° 43' 0.909" W

The gas processing facilities (gas treatment, power generation, etc.) are in the following locations, which are located in the Block 15 operated by PETROAMAZONAS:

Location Name	GPS coordinates	
	Latitude	Longitude
Central Production Facilities (CPF), including:	0° 22' 30" S	76° 37' 59" W
Limoncocha Production Facilities (LPF)	0° 20' 45" S	76° 40' 24" W
Paka Sur	0° 25' 37" S	76° 47' 35" W
Eden Production Facilities (EPF)	0° 31' 49" S	76° 07' 42" W
Yamanunka	0° 20’ 05’’ S	76° 41’ 50’’ W

Figure No. 1: Location of the Block 15

A.4.2. Category(ies) of Project Activity:

Sectoral scope 10: Fugitive emissions from fuels (solid, oil and gas).

A.4.3. Technology to be employed by the Project Activity:

The purpose of the Project Activity is to utilize associated gas that was previously flared at the Block 15 and would be flared in Block 31 in the absence of the Project Activity. Rather than continue with the current practice of flaring the associated gas PETROAMAZONAS´ intention is to use the associated gas for on-site power generation to supply the power demand of the oil field. The main reasons for currently flaring associated gas is due to the facts that i) funds within oil companies are normally prioritized for drilling and crude processing facilities; ii) the unstable nature of associated gas presents significant challenges for power generation; iii) lack of infrastructure for gas transportation.

Availability of power is essential to the oil industry since most activities involve handling fluids (oil and water) in e.g. down hole pumps, secondary crude / water piping facilities, processing facilities, water injection facilities, primary oil pumping facilities, etc. For any oil production operations power supply is essential whereby a lot of emphasis is put on its reliability since any power cut not only generates significant losses through lost production but also the potential of generating collateral damages due to down hole pumps not starting up again after a shutdown.

Most power at the Block 15 and Block 31 prior to the Project Activity, was generated with power generating infrastructure burning liquid fossil fuels (diesel and crude oil), please refer to "TECNA Report Energy Matrix Summary 2008". The following gas power generation equipment existed at the sites of the Block 15, in deteriorated operating conditions:

Model	Field	TAG	Status / Project Activity Action
Caterpillar 3516	Indillana	G 301-1, G 101-2, 3, 4, 5	• These generators only operated for a short period of time and were taken out of operation by previous operator of the oil field due to lack of reliability and inability to burn associated gas. Once taken out of operations these engines were immediately replaced by diesel generators.
Waukesha VHP 7100	Indillana	MG 102, MG 103, MG 101-9 and MG 301-3	• The MG 101-9 was operating in extreme deteriorated conditions. Part of the Project Activity is to upgrade this power generation equipment. • The MG 102, MG 103 and the MG 301-3 were not operational prior to Project Activity and as such had never operated reliably. A complete rehabilitation / upgrade program is part of the Project Activity.
Waukesha VHP 9500	Indillana	MG 101-7G and MG 101-8G	• Prior to Project Activity these had suffered a major failure and were taken off their foundations to be sold as scrap.
Waukesha VHP 5900	Limoncocha	MG 2101-1G, MG 2101-2G, MG 2101-3G, MG 2101-4G, MG 2101-5G and MG 2101-6G	• These generators were operating in extreme deteriorated conditions. Part of the Project Activity is to rehabilitate / upgrade these power generation units.
Caterpillar 3516	Limoncocha	MG 2101-7G and MG 2101- 8 G	• These generators only operated for a short period of time and were taken out of operation during the initial phase of the Project Activity due to the fact that it was apparent that this engine model cannot run reliably on associated gas. Once taken out of operations these engines were immediately replaced by diesel generators
Waukesha AT 27	Limoncocha	MG 2101-9G and MG 2101-10G	• There engines were installed by the previous operator but in a later stage it became apparent that this engine type is not suitable to operate on associated gas. Part of the Project Activity is to remove these generator sets and replace them with engines capable of running on associated gas.
Wartsila 18V34SG	Eden Yuturi	ZAN 106, ZAN 107 and ZAN 108	• These engines are designed to run on “pipeline-quality” gas but not on associated gas. Considerable investments will be made as part of the Project Activity on gas handling, gas treatment and engine “upgrade package”.

Under the Project Activity GHG emission reductions will be achieved by i) recovering the associated gas that comes from the Block 15 and Block 31, ii) implementing infrastructure to process and handle the associated gas at the various locations, iii) put in use power generating equipment that can generate power with the available associated gas and iv) put in place power distribution facilities to transport the power to the various end users.

The Project Activity has three main phases:

Installed capacity, kW	PHASE I	PHASE II	PHASE III	TOTAL
ILYP	10,150	13,000	6,000	29,150
EY	-	20,000	13,500	33,500
TOTAL	**10,150**	**33,000**	**19,500**	**62,650**

Where ILYP is the abbreviation for Indillana, Limonococha, Yanaquincha and Paka Sur. These are oil fields within the Block 15. EY stands for Eden Yuturi – the oil field within the Block 15.
The above data taken from in the ”Inventory Gas Power Generation Equipment Project Activity” is based on most recent estimates taking into account the dynamics of gas supply. It should be noted that in the previous version of the PDD (which was published for the GSP) rated capacity was used instead of installed capacity. The rated capacity is 20% lower than the installed given the fact that the anticipated utilization factor is about 80%.

The information in the ”Inventory Gas Power Generation Equipment Project Activity” may not coincide with other / previous versions but this is inherent to the nature and dynamics (uncertainty) of the petroleum sector whereby power demands, and subsequent installed capacity, are subject to continuous variations. PETROAMAZONAS therefore cannot guarantee that the attached configuration is definitive (except for the capacity that has already been installed) whereby it actually has opted for modular design to enable it to respond adequately to the continuous variations (modular design facilities demobilization and mobilization of power units and corresponding auxiliary equipment thereby reducing / mitigating certain risks).

As is today, the total projected installed capacity will reach approximately 62 MW whereby the operating capacity, subject to the availability of associated gas, will be approximately 50 MW. There are simply too many variables not under control of PETROAMZONAS (starting with actual production versus forecast and subsequently Gas Oil Ratio and corresponding gas quality) to enable it to make definitive statements. When dealing with natural gas the scenario is different since one can count on a stable fuel supply both in terms of quantity and quality. The Project scenario is nevertheless quite different in that it has to cope with a “waste product” that, both terms of quantity and quality, is unpredictable.

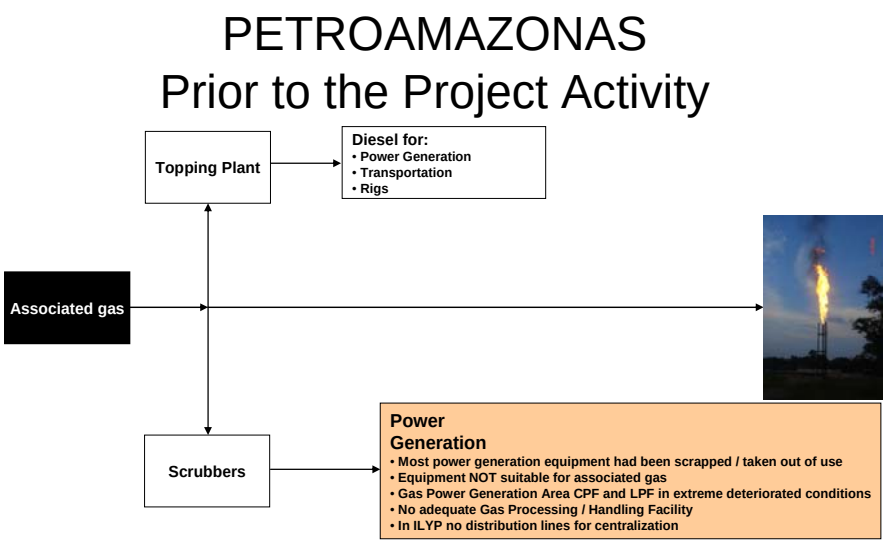
The power deficit (power not generated with associated gas) will be generated based on the following setup:

- Interconnected areas: Deficit generated with crude oil or residual fuel. For this PETROAMAZONAS plans to install a gas / crude power generation facility.
- Remote areas (not interconnected): Power generated with associated gas.

The main technological components of the proposed Project Activity are:

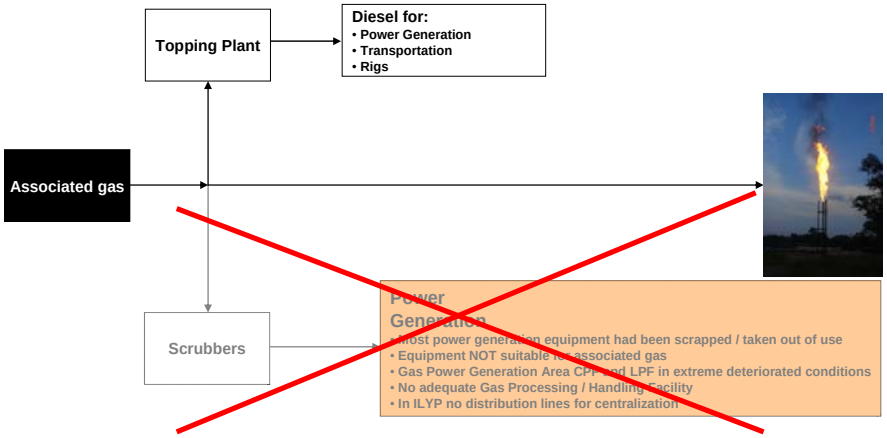
- Gas gathering facilities.
- Gas processing (compression and treatment) facilities.
- Power generation facilities (upgrade / new equipment).
- Conversion engine drivers to electrical motors.
- Electric distribution systems (switchgear, substations, distribution lines, etc.).

A general overview of i) Prior Project Activity, ii) Base Line Scenario and iii) Project Activity is given below:



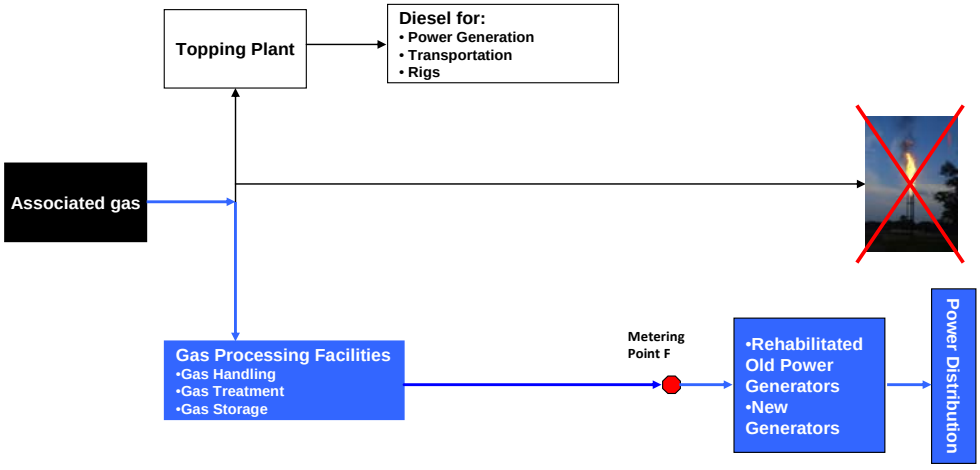
PETROAMAZONAS invested close to USD 50,000,000 in diesel and Crude oil power generation equipment to convert to 100% power generation Liquid fuels.

PETROAMAZONAS
Base Line



Due to: i) extreme poor reliability and conditions of gas power generation facilities, ii) lack of gas processing / handling facilities and iii) decision of management to go with diesel / crude oil power generation facility the Base Line scenario is running 100% of power demand with liquid fuel.

PETROAMAZONAS
Project Activity



Due to: i) extreme poor reliability and conditions of gas power generation facilities, ii) lack of gas processing / handling facilities and iii) decision of management to go with diesel / crude oil power generation facility the Base Line scenario is running 100% of power demand with liquid fuel.

Please refer to Annex 5 for detailed information concerning the situation existed before the project and planned project activities.

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

This proposed Project Activity will request a crediting period of 10 years whereby it is expected that the net GHG emissions will be reduced by approximately 970,193 **tons** CO_2 equivalents.

Years	Annual estimation of emission reductions (tons of CO_{2e})
From 2012-01-01 to 2012-12-31	181,697
From 2013-01-01 to 2013-12-31	167,102
From 2014-01-01 to 2014-12-31	137,007
From 2015-01-01 to 2015-12-31	109,326
From 2016-01-01 to 2016-12-31	89,968
From 2017-01-01 to 2017-12-31	77,728
From 2018-01-01 to 2018-12-31	62,918
From 2019-01-01 to 2019-12-31	58,050
From 2020-01-01 to 2020-12-31	47,353
From 2021-01-01 to 2021-12-31	39,044
Total estimated reductions (tons of CO_{2e})	**970,193**
Total number of crediting years	**10**
Annual average of estimated emission reduction over the crediting period	**97,019**

A.4.5. Public Funding of the Project Activity:

There is no public funding under Official Development Assistance (ODA) from Annex-I countries available for the proposed Project Activity.

SECTION B. Application of a Baseline and Monitoring Methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

The Project Activity is developed with reference to the approved methodology AM0009 Version 04 - "Recovery and utilization of gas from oil wells that would otherwise be flared or vented" as well as:
CDM Executive Board: *Validation and Verification Manual,* version 1.2
CDM Executive Board: *Tool for the demonstration and assessment of additionality*, Version 05.2
CDM Executive Board: *Tool to calculate baseline, project and/or leakage emissions from electricity consumption*, Version 01
CDM Executive Board: *Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*, Version 02
CDM Executive Board: *Guidelines on the demonstration and assessment of prior consideration of the CDM*, Versions: 01, 02 and 03

B.2. Justification of the choice of the methodology and why it is applicable to the Project Activity:

The AM0009 Version 4 "Recovery and Utilization of Gas from oil wells that would otherwise be flared or vented" is applicable to the Project Activity because it meets the specific applicability conditions of the methodology:

Applicability Criteria	Justification
Under the Project Activity the recovered gas is: - Consumed on-site to meet energy demands; and/or - Transported to and compressed into a gas pipeline without prior processing; and/or - Transported to a processing plant where it is processed into hydrocarbon products (e.g. dry gas, LPG and condensate) that are transported and sold to final consumer(s).	The associated gas will be used to produce electricity to meet own energy demand, therefore this criterion is applicable.
The project activity does not lead to changes in the process of oil-production, such as an increase in the quantity or quality of oil extracted, in the oil-wells within the project boundaries.	The Project Activity takes place downstream of any oil production and or processing activity and for that reason has no interference with the oil-production process. In case associated gas was to be re-injected this could lead to enhanced oil production but this is not the case for this Project Activity.
The injection of any gases into the oil reservoir and its production system is allowed in the project activity only for the purpose of the gas-lift process.	The Block 15 and Block 31 have not injected gas into the oil reservoirs for enhanced oil production in previous years nor is such project being considered at this time.
All recovered gas comes from oil wells that are in operation and are producing oil at the time of the recovery of the associated gas and/or gas-lift gas.	The Project Activity only considers associated gas from wells producing oil at the time of the recovery. Within the Blocks operated by PETROAMAZONAS there are no gas wells /

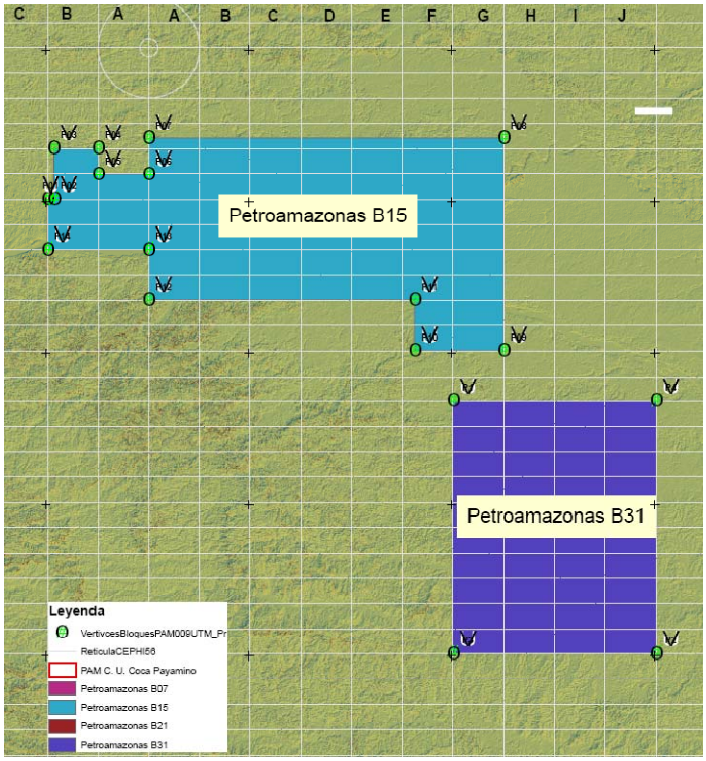
	fields and 100% of the gas is associated gas extracted from the reservoirs with crude oil and water. The provided list of wells demonstrates that that none of them are exclusively gas or gas-water wells within the project boundaries.
Finally, the methodology is only applicable if the identified baseline scenario is: 1) The continuation of the current practice of either venting (scenario G1) or flaring (scenario G2) of the associated gas and/or gas-lift gas; and 2) The continued operation of the existing oil and gas infrastructure without processing of any recovered associated gas and/or gas-lift gas and without any other significant changes (scenario P4); and 3) In the case where gas-lift is used under the project activity: the gas-lift gas under the baseline uses the same source as under the project activity and the same quantity as under the project activity (scenario O1).	1) All associated gas would be flared in absence of the project implementation. Please refer to the baseline identification section, scenario G2. 2) The most probable baseline scenario is the practice that existed before the Project implementation i.e. continued power generation with liquid fossil fuel without processing recovered gas and without any other significant changes. Please refer to the baseline identification section, scenario P4. 3) Is not applicable since the Project does not involve gas-lift.

As it is demonstrated in the table above AM0009 version 4 is fully applicable.

B.3. Description of the sources and gases included in the Project Boundary:

The Project boundary encompasses:

- The project oil reservoirs of PETROAMAZONAS where the associated gas is collected are the following: the Block 15 and Block 31;
- The site where the associated gas was or would be flared in the absence of the Project Activity, which in this case is at the Block 15 and Block 31;
- The gas recovery and handling (compression, treatment, buffer, etc) at the Block 15.



The proposed Project Activity comprises of new gas processing facilities and power generation and distribution facilities whereby the recovered associated gas will be treated to:

(i) Withdraw excess CO_2 to meet minimum LHV standards (in fields where the gas has a high enough LHV CO_2 removal is not required); and,

(ii) Withdraw the condensates that inhibit power generation equipment from generating with gas; and,

(iii) Condition (composition and pressure) the associated gas to convert it into fuel gas for power generation whereby certain minimum parameters apply in terms of LVH, pressure, octane number, etc.

(iv) Compress gas and store certain volumes in recipients to create a minimum buffer to compensate for unstable supply.

The GHGs included in or excluded from the Project Boundary are shown in the following table (see also Fig. No. 3):

Source		Gas	Included?	Justification / Explanation
Baseline	Combustion of diesel/crude oil at end-users that are purchased / produced for power generation	CO_2	Included	Emissions from combustion of fossil fuels used for power generation
		CH_4	Excluded	To be conservative it is assumed that the flaring system has a 100%

				destruction efficiency.
		N_2O	Excluded	It is assumed as negligible.
Project Activity	Energy use for the recovery, pretreatment, transportation, and if applicable, compression of the recovered gas	CO_2	Included	Emissions due to the use of energy that is produced by other fossil sources.
		CH_4	Excluded	It is assumed as negligible.
		N_2O	Excluded	It is assumed as negligible.

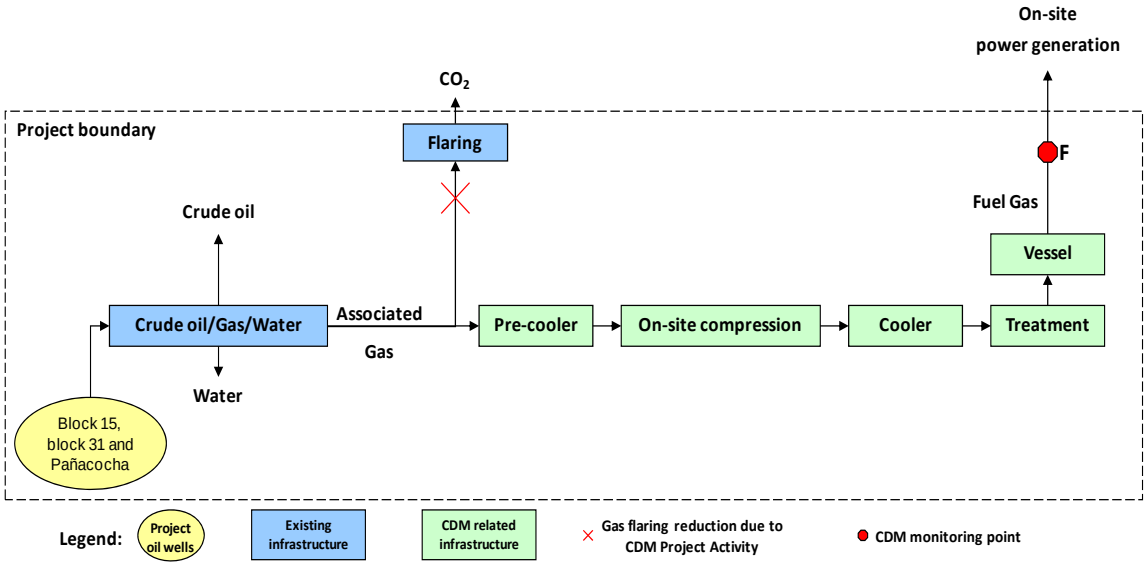


Figure No. 3: Schematic view of the project boundary and monitoring point.

B.4. Description of how the Baseline Scenario is identified and description of the identified Baseline Scenario:

According to the methodology, the following plausible alternative scenarios should be considered:

Plausible alternative baseline scenarios for the associated gas and/or gas-lift gas from the project oil wells:

G1: Release of the associated gas into the atmosphere at the oil production site (venting)	Gas venting (or flaring) is subject to authorization according to the law[3]. Flaring is the normal practice at PETROAMAZONAS´s facilities today due to several reasons: venting of associated gas in the available quantities would be dangerous both to operators due to a risk of explosion and to environment due to contamination by its components. As demonstrated to DNV during the site visit the flaring practice followed by PAM

[3] Ley de Hidrocarburos

	(please see "Annual authorization for the use and burning of gas at the Block 15, 2008" and "Authorization of use and flaring of associated gas at PETROAMAZONAS EP operations, 2009") and therefore venting is not considered as an alternative baseline scenario.
G2: Flaring of the associated gas at the oil production site	At the Project Activity sites, gas has been flared since the start of operation of the fields. There are no regulations preventing PETROAMAZONAS EP from continuing to flare the gas. Moreover, gas flaring is widely applied in the Ecuadorian Oil industry. The Ministry of Electricity and Renewable Energy illustrates that approximately 80% of the associated gas is flared (see details in "Strategic policies to change the energy matrix"). In other words, there is no incentive to change the current practice. Therefore, this alternative is viable.
G3: On-site use of the associated gas for power generation	This alternative is the considered as the Project Activity. Section B.5 demonstrates that it is not viable baseline scenario.
G4: On-site use of the associated gas for liquefied natural gas (LNG) production	There is no infrastructure, and consequently, no market for LNG in Ecuador (see Energy Information Administration[13] details in Annex 3). Furthermore, a significant gas production volume (critical mass) is required together with a guaranteed long-term supply contract, to make an LNG plant and terminal economically viable. Therefore, it is concluded that this scenario is not feasible and will not be evaluated further.
G5: Injection of the associated gas into an oil or gas reservoir	Since there are no standard geological settings that will guarantee an improvement in oil production rates, each field must be evaluated on a case-by-case basis for suitability of gas injection. In other words, there is no certainty that gas injection at the Block 15 and Block 31 will enhance oil recovery. Furthermore, the Block 15 and Block 31 produces a relatively small volume of associated gas, which must be balanced against the fact that gas injection is a technically complex process and capital and energy intensive. Therefore, this option is not viable.
G6: Recovery, transportation, processing of the associated gas and distribution of products thereof to end-users without being registered as a CDM project activity	Due to the lack of infrastructure to bring gas to potential end users, lack of economy of scale due to few potential large volume end users (see public references in Annex 3)) and capital intensive investments required to put in place the required

	infrastructure, this alternative is not viable.
G7: Recovery, transportation and compression of the associated gas and/or gas-lift gas into a gas pipeline without prior processing, without being registered as a CDM project activity	This alternative requires high investment to construct compression stations and a pipeline to the nearest processing plant while there is a low demand for the gas and inadequate infrastructure. For these reasons, it is concluded that this scenario is not feasible.
G8: Consumed on-site to meet energy demands without being registered as a CDM project activity	This alternative corresponds with the proposed project and is very similar to scenario G3. This alternative is not viable and this is demonstrated below in section B.5.
G9: Recovery, transportation and utilization of the associated gas as feedstock for manufacturing of useful products	This option is not a realistic, as Ecuador currently does not have the petrochemical industry where associated gas could serve as a feedstock. Therefore, the option is not a viable baseline scenario.

From the scenarios identified and evaluated above, only one scenario is considered as realistic and viable:

G 2: Flaring of the associated gas at the oil production site

Plausible alternative baseline scenarios for oil and gas infrastructure:

P1: Construction of a processing plant for processing the recovered gas, in the same way as in the project activity, without being registered as a CDM project activity	This alternative corresponds to the proposed Project Activity and below in section B.5. it is demonstrated that this option is not viable without the benefits of CDM.
P2: Construction of a processing plant of a lower capacity than under the project activity, which processes only non-associated gas and no recovered gas	This alternative is not viable, apart from associated gas from the Block 15 and Block 31, there are no other sources of gas.
P3: Supplying recovered gas to an existing gas processing plant and constructing the necessary infrastructure, without being registered as a CDM project activity	This alternative requires high investment to construct compression stations and a pipeline to the nearest processing plant, which is very far away, while there is a low demand for the gas and poor infrastructure. For these reasons, it is concluded that this scenario is not feasible.
P4: Continuation of the operation of the existing oil and gas infrastructure without processing of any recovered associated gas and/or gas-lift gas and without any other significant changes	No additional infrastructure is needed to continue flaring associated gas from the various fields. For this reason, this is a viable alternative under the assumption that PETROAMAZONAS would not develop the CDM Project Activity.
P5: Supplying recovered gas to a gas pipeline without prior processing and without being registered as a CDM project activity	For the same reasons as indicated for alternative P3, this alternative is not a viable.

From the scenarios identified and evaluated above, only one scenario is considered to be realistic and viable:

P4: Continuation of the operation of the existing oil and gas infrastructure without processing of any recovered associated gas and/or gas-lift gas and without any other significant changes.

Plausible alternative baseline scenarios for the use of gas-lift: this is not applicable as there is not gas-lift used under the project activity.

Based on the considered alternative the baseline was identified as G2 (Flaring of the associated gas at the oil production site) and P4 (Continuation of the operation of the existing oil and gas infrastructure without processing of any recovered associated gas and/or gas-lift gas and without any other significant changes) in other words, the situation existed before the project implementation.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

Prior consideration of CDM

On February 12, 2009 the Initial budget for the Project Activity was approved by PETROAMAZONAS EP and the Ministry of Finance whereby this date is considered the Project Activity Starting Date since as of that date funds were available to implement the Project Activity. CDM benefits were a key component of the Conceptual and Detailed Engineering of the Project Activity that formed the basis for the budget allocation.

Additional activities / actions undertaken by PETROAMAZONAS related to CDM Project Activities are laid out below:

- *March 2009:* Based on the initial study by Power Latin America Inc. PETROAMAZONAS EP hired an "in-house" CDM officer/specialist to address CDM registration of the OGE Project.
- *March 18, 2009*: PETROAMAZONAS EP submitted an official letter to the Ministry of the Environment (the Ecuadorian DNA) to inform its intentions to develop the CDM Project Activity and its intention to seek CDM status. Approximately one month later, the DNA confirmed receipt of PETROAMAZONAS letter indicating that it would support Project Activities with the objective to grant National Approval Status.

Identification of the baseline scenario and demonstration of additionality

For identifying the baseline scenario, the procedure laid out in methodology AM0009 "Recovery and utilization of gas from oil wells that would otherwise be flared or vented" was applied.

In general terms, this analysis requires:

a) Step 1: Identification of all the plausible alternative scenarios
b) Step 2: Evaluation of legal aspects
c) Step 3: Evaluation of the economic attractiveness of alternatives
d) Step 4: Common practice analysis

Apart from the Additionality tool, indicated in the "Tool for the demonstration and assessment of additionality" (Version 05.2), it is also using the Additionality approach included in the AM0009 methodology whereby it is assumed that both are mandatory.

STEP 1: IDENTIFY PLAUSIBLE ALTERNATIVE SCENARIOS

The previous section identified the baseline scenario. In addition the Project Scenario without being registered as a CDM project should be considered a viable alternative.

STEP 2: EVALUATE LEGAL ASPECTS

From the scenarios identified and evaluated above, two scenarios are considered realistic and viable; whereby, a legal assessment is made to demonstrate compliance of these alternatives

- 1 i.e. the baseline scenario i.e. G2 and P4 and
- 2 i.e. the project scenario i.e. G3, G8 and P1.

The laws that related to the use of associate gas are laid out in the Hydrocarbons Law *(Ley de Hidrocarburos)* Articles 34, 35, 36, 39, and 41. In general, oil companies (operators) can use associated gas for their operations upon obtaining approval from the National Directorate of Hydrocarbons (DNH)[4]. Some oil companies in Ecuador use associated gas for power generation in locations where there are no technical barriers and or under circumstances where from the initial "drawing board" phase associated gas optimization was one of the project design criteria (considering "green field" projects).,

Article 34 complicates the commercialization of flare gas by stipulating that natural gas obtained from exploitation of oil deposits belongs to the State and can only be used by the contractors or associates in the quantities necessary for operation of exploitation and transport or for re-injection in the deposits after previous authorization from the Ministry of Oil and Mining. In condensate fields or deposits with a high gas to oil relation, the Ministry of Oil and Mining can demand recirculation of the gas.

Sale of excess gas is addressed by Article 35. It states that the State of Ecuador, through e.g. PETROECUADOR, can enter into additional contracts with its respective contractors or associates or into new contracts with other with a recognized technical and financial capacity to use the gas derived from the oil deposits for industrial or commercial use. PETROECUADOR can also extract the liquefiable hydrocarbons from the gas extracted by the contractors or associates.

Article 36 states that if PETROECUADOR wants the gas for industrial purposes, generation of electricity, commercial use, or any other use, contractors or associates shall at no cost hand over to PETROECUADOR the gas they extract and do not use for their own production purpose. In such cases, PETROECUADOR will only pay the transfer cost incurred by the contractor or associates.

Given the legal framework, both baseline scenarios are clearly permitted by law therefore making them legally viable baseline alternatives. Furthermore, alternative (2) is also covered by an approved ex-post Environmental Impact Assessment or Internal Environmental Audit, which is required to comply with the Environmental Law (see Section D).

In conclusion, alternative scenarios (1) and (2) comply with all applicable legal and regulatory requirements. Thereby it is feasible to proceed with the economic evaluation of the alternatives.

STEP 3: EVALUATING THE ECONOMIC ATTRACTIVENESS OF THE ALTERNATIVES

The economic attractiveness is assessed for those alternative scenarios that are feasible in technical terms and that were identified as being permitted by law in Step 2. The economic attractiveness is assessed by determining an expected Internal Rate of Return (IRR) or Net Present Value (NPV) of each alternative scenario, following the guidance for the investment analysis in the latest approved version of the "Tool

[4] The Directorate is responsible for the development and implementation of the country's hydrocarbon policy and for enforcing the Hydrocarbon Law. It can introduce regulations needed for the appropriate implementation of the law. The Directorate approves or authorizes all phases of the hydrocarbon activities, including the oil companies' plans and budgets for investment; sets limits for oil production; authorizes and monitors the construction of oil and gas pipelines; and controls and monitors the market for LPG. Revenues derived from permits, sale of information, and fines finance the Ministry's administration.

for the demonstration and assessment of additionality – version 5.2". The IRR will be determined using the following parameters as applicable to the relevant scenario:

- Overall projected production of associated gas based on the oil production forecasts.
- The projected quantity of gas recovered, gas flared, consumed on-site, processed in a gas handling / processing plant to meet energy demands.
- The net calorific value of the recovered gas
- Capital expenditure for all power generation, power distribution and gas infrastructure needed in the relevant scenario (CAPEX). For more detail, see Table No. 3 Section A.4.3.
- All operational expenditure associated with the respective scenario (OPEX).
- Any cost recovery, such as cost savings through the substitution of products by the recovered gas as the substitution of diesel by associated gas.
- Residual value of machinery and equipment

It is important to note that there is not an agreed upon price for associated gas in Ecuador; therefore, the gas has no monetary value.

Critical to analyzing, and consequently determining the economic parameters of the alternative scenarios, are the following considerations:

A. Overall projected production of associated gas:

The projected associated gas production depends on the volume of crude oil and the expected ratio of associated gas. The gas production estimates used for the Project Activity are based on production forecasts from PETROAMAZONAS EP that was issued by the head of Operations in February 2009. Later on this was substituted by a forecast scenario specific for the Project Activity because previous forecast reports did not span the period of the Project Activity.

B. The projected quantity of gas recovered, flared and consumed on-site:

Beyond the generic factors above, the amount of gas recovered (for use) depends on the following factors influencing the gas gathering ability.

- *Power demand at site*:
  - Power demand corresponds to the total fluid production (crude oil and water). Power demand moves in line with the amount of fluids that must be handled (pumping, processing, injecting, etc.). To monitor this, PETROAMAZONAS EP tracks the ratio between the volume of fluids (crude oil and water - in Fluid Barrels per Day) and the electric power demand (kW) using a kW / BFPD ratio. This ratio is dynamic and varies depending on the total volume of oil and water, the water cut and reservoir characteristics.
- *Gas characteristics*:
  - Gas supply characteristics - gas comes in batches to the central production facilities because gas separates prematurely in the secondary gas supply lines.
  - Gas chromatography (Methane, CO_2, Butane, Propane, LHV, etc.) can vary considerably over time. It is not unusual to find the initial levels of CO2 in associated gas increase from 10% to 50% over time.

Chart No.1 below summarizes the gas quantities available to PETROAMAZONAS EP at the Block 15 and Block 31 based on the analysis above. From the chart, it becomes evident that the volume of available gas is not sufficient to generate 100% of the power demand.

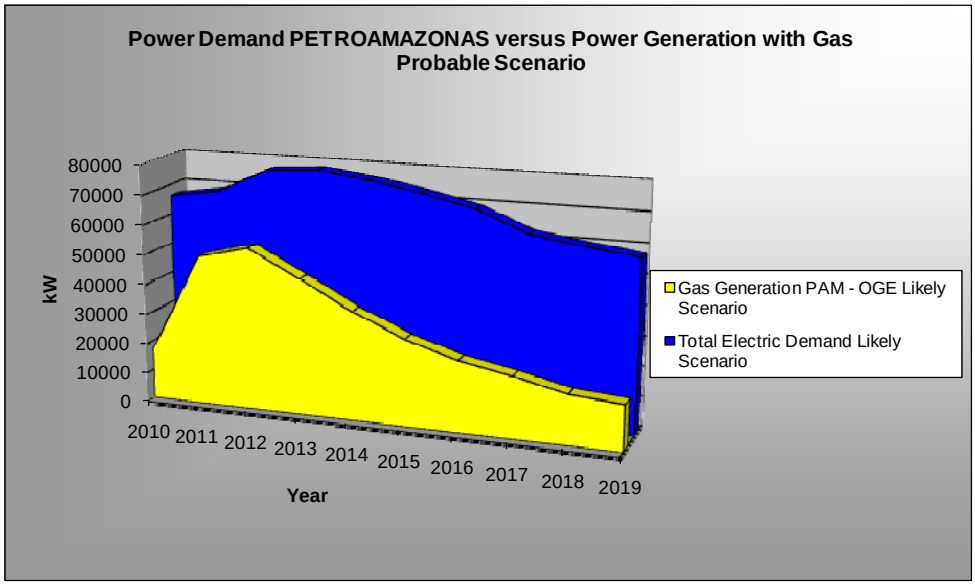


Chart No. 1 : Power demand vs. potential power generation with gas Probable Scenario.

C. The net calorific value of the gas (characteristics / dynamics):

The dynamics of associated gas, and the solutions implemented to mitigate these, are determining factors in the success / failure of the proposed Project Activity. The following dynamics / variables are issues that have to be dealt with to assure the technical and economical success of the Project Activity:

- Future volume of associated gas is subject to constant variations.
- Gas supply is inherently inconsistent, meaning that gas comes in batches with significant variation between "high" and "low" volumes.
  In determining the net calorific value of associated gas, the gas compositions (share of methane, CO_2, butane, propane) is essential whereby this varies overtime and sometimes even abruptly depending on which wells are on line, maturity of the fields, reservoirs that are being tapped into, etc.

D. Capital Expenditures (CAPEX):

CAPEX are the investment costs associated with the implementat$_i$on of the proposed Project Activity. These total US$81.6 million. Please see Investment Schedule in the Investment Analysis for a summary of capital expenditure.

E. Operational Expenditures (OPEX):

Given the fact that the baseline represents the situation where only diesel/crude oil power generators and appropriate auxiliary equipment would be used the operational costs in such case are lower than in the project as diesel/crude oil generators will be complemented by gas generators which makes it more costly

to operate. Nevertheless, operating costs for the infrastructure required for the Project Activity are assumed to be equal to the operating costs in the baseline scenario. Hence, (incremental) Operational Expenditures are zero and such assumption is conservative.

F. Costs savings:

The Project Activity optimizes the use of recovered associated gas for power generation to meet part of the power demand on the Block 15 and Block 31. The balance of energy demand (shortfall) is met with diesel or crude oil. The economic evaluation accounts for the cost savings (avoided cost) from reduced purchases of diesel fuel for power generation. Diesel prices are regulated and fixed by the Government of Ecuador. [5] The economic analysis assumes a constant price of diesel of 0,91 USD per gallon, based on the long-term average subsidized price of diesel in Ecuador. PETROAMAZONAS EP also operates a topping plant that produces approximately 20,000 gallons per day of which approximately 80% is used for power generation. The cost of this fuel is considered zero for PETROAMAZONAS EP. The amount of diesel produced by the topping plant covers roughly 30% of demand.

G. Residual value of assets:

PETROAMAZONAS EP accounting procedures apply a 10% straight-line depreciation rate for equipment and machinery. The book value of equipment and machinery is therefore zero at the end of the lifetime.
Based on the projects' investment budget, 61,4% of the total cost is assigned to machinery and equipment, or US$ 50 million. A residual value of US$ 10, million is included in the investment analysis.

H. Economic Evaluation of attractiveness of alternatives:

Baseline Alternative 1 represents the situation in which flaring of the associated gas would continue under current practices; no increase in capital expenditure is required and, no new revenue is generated. On the basis of the investment analysis guidance in "Tool for the demonstration and assessment of additionality" (v5.2), we will apply the benchmark analysis.

The benchmark analysis for Baseline Alternative 2 presented here is based on an IRR calculation and economic parameters used by PETROAMAZONAS for evaluating the feasibility of the Project Activity:

ECONOMIC PARAMETERS	
CAPEX (US$)	81,671,975
OPEX (US$)	0
AVOIDED / SAVING COSTS (US$)	80,063,846
LIFETIME (YEARS)	10
RESIDUAL BOOK VALUE OF ASSETS (US$)	10,042,566
DISCOUNT RATE (%)	16%

[5] See details at http://www.petrocomercial.com/wps/portal

Based on the indicated economic parameters and criteria the key financial indicators for the proposed Project activity were calculated:

KEY FINANCIAL INDICATORS	
TOTAL NPV @ 16% (US$)	-21,494,654
IRR (%)	2,44%

The economic analysis in the financial model shows an IRR of 2,44% for the Project Activity. This level of return lies clearly under the hurdle rate of 16% estimated by PETROAMAZONAS. The hurdle rate was estimated based on Return on Equity as per Capital Asset Pricing Model (CAPM). The CAPM relates the required return on equity to its relative volatility (non-diversifiable risk) compared to the stock market as a whole. CAPM is commonly used to estimate the cost of equity. The hurdle rate of 16% was calculated on the basis of the 2-year average rate of 20-year US treasury bond and the 2-year average country risk premium for Ecuador, as reported by the Central Bank of Ecuador and derived from the JP Morgan Emerging Markets Bond Index. The market risk premium of 11,30% for the project is conservatively assumed to equal the country risk premium given that PETROAMAZONAS is a state-owned company. Commercial credit, if available, would likely include sector and project risk premiums on top of the country risk premium and apply a higher market risk premium.

I. Sensitivity Analysis:

This section summarizes the sensitivity analysis for testing the above conclusion regarding the economic attractiveness of the Project Activity. Key parameters are modified to test under what assumptions the project would meet the benchmark.

CAPEX:

Given the fact that the Project Activity is integrated into existing facilities that in some cases are considerably deteriorated, the risk of cost overrun is considerable. A situation where capital costs would decrease seems highly unlikely. According to the sensitivity analysis the capital costs would need to decrease by 35,9% in order for the project to meet the benchmark. This is not possible, given the fact that as of the end of 2010 66,24% of the total planned budget were spent, please refer to the "OPTIMIZATION OF POWER GENERATION PROJECT.XLS ", the tab "CURVA PROG OGE". Therefore, only 33,76% of the total planned budget left while the project could hit the benchmark if the budget would be less by 35,9% from the initially planned. Moreover, inflation takes place in Ecuador and it is expected that the CAPEX will increase, please refer to:
http://www.indexmundi.com/ecuador/inflation_rate_%28consumer_prices%29.html (Ecuador Inflation rate (consumer prices) - Economy.pdf).

PRODUCTION GAS PROFILE:

An increase in Project returns could also be triggered by an increase in gas volumes. However, this is technically unlikely as the amount of gas that can be utilized is capped by the total amount of gas-based generation capacity installed under the Project Activity. A hypothetical increase in gas volumes would only benefit the project after 2013 once projected gas volumes start to diminish. The impact on the Project's profitability is minimal. A gas volume increase beyond 121% does not yield any additional returns as the limitation of the available capacity caps the

benefit of increases in gas volume. The equity IRR of the project does not increase beyond 7,48% regardless of how much gas volumes would increase.. Hence, we can conclude that an increase gas volumes does not materially affect the outcome of the additionality analysis.

PRICE OF DIESEL:

As long as the Government of Ecuador (GOE) maintains its current fiscal subsidies to support a domestic diesel price of 0,901 $/gal this variable will have no impact on the IRR of the Project. The subsidized price has remained at their current levels for the last years period. Overall, it is very unlikely that diesel subsidies will be eliminated in the short term in Ecuador because in the past policies related to passing on the real energy cost to the end users went hand in hand with a high political cost. The price of diesel would have to increase by 59% in order for the Project to meet the benchmark. This is highly unlikely. Hence, we can conclude that any reasonable increase in diesel prices does not materially affect the outcome of the additionality analysis.

GENERATION CAPACITY ADDITIONS

Given the uncertain nature of gas availability and volume, the total installed gas-based generation capacity at the Block 15 and Block 31 through the Project Activity may be higher. From recent projections it is evident that the capacity in ILYP is now likely to exceed a guaranteed capacity of 27.5MW by 1.65MW[6]. In order to account for this fact and ensure the conclusions from the additionality test remain intact, the sensitivity of the equity IRR of the project to capacity additions has been tested. For the purpose of conservativeness we have assumed that *all* additional capacity is added at no cost and only at ILYP (where cost savings against diesel accrue). The sensitivity analysis shows that the available gas volumes cap the potential increase in IRR to 9.71% for capacity additions of 240% (16.5MW) and more. We can therefore conclude that a potential increase gas-based generation capacity does not impact the outcome of the additionality analysis because the project returns will remain well under the benchmark even in the most conservative situations where capacity may differ from the guaranteed capacity of 27.5MW in ILYP and 33.5MW in EY.

The table below summarized the sensitivity analysis.

SENSITIVITY ANALYSIS	
PARAMETER	**Required change for IRR to reach benchmark**
CAPEX	-35,9%
PRODUCTION GAS PROFILE	+121% (IRR capped at 7,48%)
PRICE OF DIESEL	+59%
ADDITIONAL GAS-BASED GENERATION CAPACITY	+240% (IRR capped at 9,71%)

On the account of the analysis above we can conclude that the Project Activity IRR would meet the benchmark only through highly unrealistic changes in key operating parameters.

[6] Please see Inventory Gas Power Generation Equipment Project Activity for the latest projections on associated gas-based capacity additions

I. Conclusions from the analysis of Economic Attractiveness

- The equity IRR of 2.44% is well below the current investment benchmark for PETROAMAZONAS.
- Based on the sensitivity analysis, the proposed CDM Project Activity is unlikely to be financially/economically attractive and evaluation can proceed to Step 4 (Common Practice Analysis).

STEP 4: COMMON PRACTICE ANALYSIS

Sub-step 4a: Analyze other activities similar to the proposed project:

Some associated gas-to-power projects have been developed in Ecuador, however, only as greenfield projects. The first projects that were developed using associated gas for power generation were developed by PETROPRODUCCION (subsidiary of PETROECUADOR) and ENCANA (now ANDES PETROLEUM) in 1999 and 2004.

The other oil companies that have optimized associated gas for power generation are REPSOL YPF Ecuador and PETROBRAS for Blocks 16 and 18 respectively. Block 16 has 21 x 1 MW Waukesha engines plus 3 x LM 2500 gas turbines (which run on both diesel and gas). PETROBRAS has installed 2 x 6 MW steam turbines[7].

In addition to the above, PETROECUADOR identified in 2007 four potential projects to reduce GHG emissions with support from the Global Gas Flaring Reduction Initiative to support the write up of Project Idea Notes (PINs), Based on recent personal communication[8] and official reports, these projects seem to have stalled or been seriously delayed.

Sub-step 4b: Discussion of any similar Options that are occurring:

In spite of similar activities not being widely observed and commonly carried out, an explanation on essential distinctions between the proposed Project technology and similar activities is given below. The Project Activity is the first project in Ecuador to optimize associated gas by means of fundamentally restructuring the existing set-up, facilities and power generation and distribution topology at an existing oil field. This approach is far more capital intensive, and also involves far higher risks, than the above mentioned greenfield projects that have considered flare gas optimization as a part of overall new oil field development. The above projects were developed to burn associated gas from the start of the operations and are therefore conceptually, and from a project execution point of view, completely different projects than the Project Activity. In greenfield projects the capital expenditure associated with the capture of associated gas plays a marginal part of the overall cost of developing the field as the design, construction and maintenance costs relating to associated gas capture and utilization is included in the overall cost-benefit calculation of a new oil field. Gas capture and utilization engineering work plans are integrated

[7] Pástor S. (Technical Manager). PETROBRAS, *"Utilisation of High CO2-Content Flare Gas for Steam and Electricity Generation"*, presented at the Global Forum "On flaring and Venting Reduction and Natural Gas Utilisation" held in Amsterdam, 2008.

[8] Personal communication of Mrs. Ana María Nuñez, former Project Officer in CORDELIM (the National CDM Promotion Office), anitamarianunez@gmail.com, and Mr. Francisco Sucre, expert of GGFR/coordinator of the Oil & Gas CDM/JI Methodology Workgroup, fsucre@worldbank.org.

into the overall field development plan, significantly reducing operational, technical and performance related risks in comparison with the Project Activity.

More importantly, afore mentioned private oil companies pay international prices for diesel, i.e. they are not eligible for subsidized fuels. Furthermore, any crude oil they use for power generation has an "opportunity cost" since it is crude oil they could have sold in the international market. This means that they get direct economic benefits from savings in both crude oil and diesel; through increased sales of crude and reduced cost of purchasing diesel. As a result, the associated gas utilization projects developed by private oil companies in Ecuador operate on completely different economic terms than the Project Activity. The financial viability of these projects is therefore likely on a much higher level than the returns provided by the Project Activity.

SUMMARY OF ASSESSMENT AND DEMONSTRATION OF ADDITIONALITY

INDENTIFIED PLAUSIBLE SCENARIO (STEP 1)	LEGAL ASPECTS (STEP 2)	ECONOMIC ATTRACTIVENESS (STEP 3)	COMMON PRACTICE (STEP 4)
Alternative 1 (combination of G2 – P4): Continuation of the operation of the existing oil gas infrastructure without processing of any recovered gas that implies continuation of the current practice – gas flaring).	Not prohibited by law	• Business as usual. • No additional risk involved. • No additional funds required. • NPV 0	Common practice: Flaring is widespread for oil fields in Ecuador.
Alternative 2 (combination of G8 – P1): Construction of a processing plant for the purpose of processing the recovered gas which is consumed on-site to meet energy demands without being registered as a CDM project activity.	Not prohibited by law. Although, associated gas recovery is recommended; this is not mandatory.	• Capital intensive. • Additional risks. • Lacks Economic Incentive due to: i) Crude oil for power generation is free of charge and ii) diesel is subsidized.	Given the indicated hurdles, optimizing flare gas in existing oil production facilities is NOT common practice in Ecuador.

Based on the analysis in the steps above, it is concluded that the Project Activity is additional. This is supported by the facts that:

- Baseline Alternative 2 does not represent the financially most attractive course of action

Existing power generation facilities of Block 15 are already supplying the existing power demand of the Block 15 and Block 31; the Project Activity is not essential to maintain crude oil production operations

- The financial return of the Project Activity does not meet the identified threshold
- Gas flaring in the oil industry in Ecuador is common practice

Hence, the project is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

Baseline emissions

The baseline emissions are according to AM0009 version 04 and related to those emissions that would be generated in the absence of the Project Activity therefore generating power with other fossil fuels. Project activities under this methodology reduce emissions by recovering associated gas and utilizing this recovered gas in a productive manner. The utilization of the recovered gas displaces the use of other fossil fuel sources.

The proposed Project Activity comprises the utilization of the recovered gas to displace the use of diesel and crude oil as sources to generate power at PETROAMAZONAS' facilities. However, the AM0009 provides for a simplified and conservative calculation of emission reductions, assuming that the use of recovered gas displaces the use of methane – the fossil fuel with the lowest direct CO2 emissions.

Hence, baseline emissions are calculated as follows:

$$BE_y - V_{F,y} \cdot NCV_{RG,F,y} \cdot EF_{CO2,Methane}$$

Where:

BE_y = Baseline emissions during the period y, (tCO2e)

$V_{F,y}$ = Volume of total recovered gas measured at point F in Figure No.7, after pre-processing and before the part of the recovered gas may be used on-site, during the period y, (Nm^3)

$NCV_{RG, F, y}$ = Net calorific value of recovered gas measured at point F in Figure No.7 during the period y, (TJ/Nm3)

$EF_{CO2, methane}$ = CO2 emission factor for methane (tCO2/TJ)

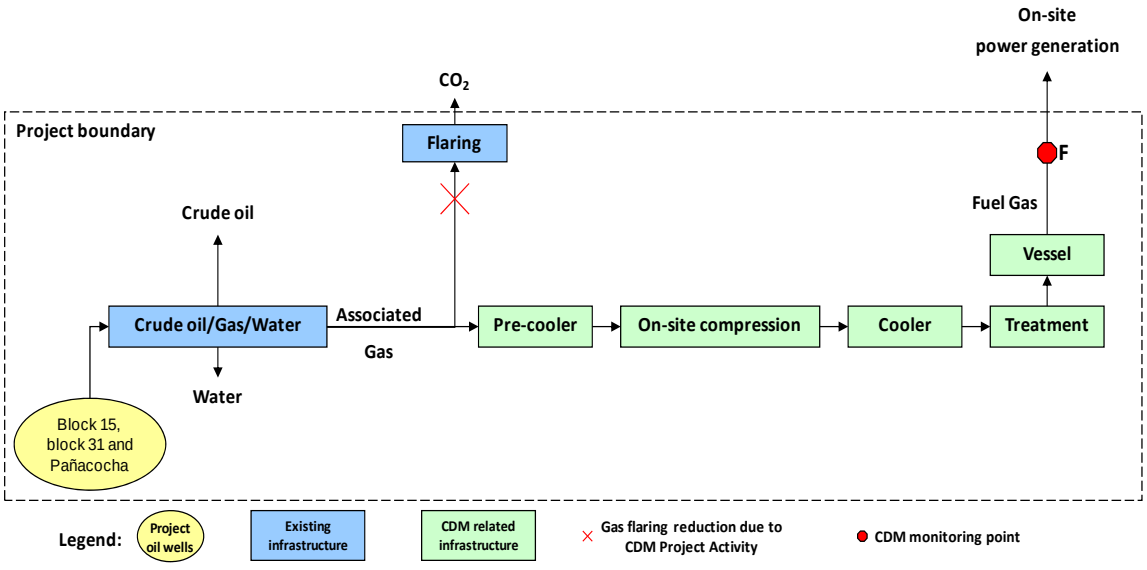


Figure No. 4: Schematic illustration of the project activity

Project emissions

The following sources of project emissions are accounted for in AM0009 version 04:

1. CO_2 emissions due to consumption of fossil fuels for the recovery, pre-treatment, transportation, and, if applicable, compression of the recovered gas up to the point of delivery into an existing gas pipeline (point C in Figure 2 in AM0009);
2. CO_2 emissions due to the use of electricity for the recovery, pre-treatment, transportation, and, if applicable, compression of the recovered gas up to the point of delivery into an existing gas pipeline (point C in Figure 2 in AM0009).
3. The project emissions[9] to be accounted for are the CO_2 emissions related to the electricity generated and consumed by the gas handling (compression and treatment) systems up to Point "F" as indicated in Figure 4.

Project emissions are calculated as follows:

$$PE_y = PE_{CO2,fossilfuels,y} + PE_{CO2,elec,y}$$

Where:

PE_y = Project emissions in the period y, (tCO2e)

$PE_{CO2,fossilfuels,y}$ = CO_2 emissions due to consumption of fossil fuels for the recovery, pre-treatment, and, compression of the recovered gas up to the point F in Figure 5 during the period y, (tCO2e)

$PE_{CO2,elec,y}$ = CO_2 emissions due to the use of electricity for recovery, pre-treatment, and, compression of the recovered gas up to the point F in Figure 5 during the period y, (tCO_2e)

No other fossil fuel is used for powering the auxiliary systems related to the Project Activity, as all auxiliary equipment is supplied with electric power generated with associated gas. Project emissions therefore are limited to additional electric power consumption required for auxiliary equipment that are a part of the Project Activity (principally gas handling equipment) which nevertheless, and indicated previously, will be generated with associated gas.

Hence,

$PEy = PE_{CO2,elec,y}$

At time of validation, the project is at construction stage and the final design is not 100% clear. Thus, two approaches are considered in order to calculate project emissions from electricity consumption. Both approaches are in line with AM0009 and "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"
(Version 01).

Depending on the project's actual "as built" engineering design either one or the other or a mix of these approaches will be chosen to calculate actual emissions. Similarly, the monitoring system might change during the project's life time. In other words, it is possible that one approach will be used during one verification while the other approach can be applied during another verification.

[9] Other sources of project emissions such as emissions from leaks, venting and flaring during the recovery, transportation and processing of recovered gas are assumed to be of similar magnitude in the baseline scenario.

Generic approach for both options:

Where:
$P_{CO2,elec,y}$ = Project emissions from electricity consumption in year y (tCO_2/yr)
$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
$EF_{EL,j,y}$ = Emission factor for electricity generation for source j in year y (tCO_2/MWh)
$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to project auxiliary gas handling equipment j in year y
j = Sources of electricity consumption in the project

As per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01), the project falls under scenario B ("Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s)"). TDL is assumed as zero for the both approaches.

Approach 1 (ex-post) – no direct measurement of $EC_{PJ,j,y}$:

The quantity of electricity consumed ($EC_{PJ,j,y}$) by the auxiliary gas handling equipment (refinery/ies) is calculated based on: the rated consumption (MW) of the refineries and the actual load of gas-based electricity generation equipment (gas generators). The load of gas generators has direct relation to the load of refineries, and it is established in the formula below. Rationale: the amount of gas to be pre-treated is always in line with gas consumed by gas generators, and gas consumption directly affects amount of electricity produced. In other words, load factors of these equipments are in direct correlation to each other. Emission factor ($EF_{EL,j,y}$) is taken from the approach 2 or assumed to be 1.3 tCO_2/MWh, the most conservative assumption as per the scenario B2 of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01).

Under approach 1 ($EC_{PJ,j,y}$) will be calculated with the following formula:

Where:
$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in the year y (MWh/yr)

$EN_{aux,y}$ = Nominal capacity of auxiliary (gas handling) equipment for gas-based energy generation (MW) in year y

$EG_{gas,j,y}$ = Quantity of electricity generated by gas-based energy generators (MWh) j in the year y

$EN_{gas,j,y}$ = Nominal capacity of gas-based energy generation equipment j (MW) in year y

j = Sources of electricity generation in the project

Approach 2 (ex-post) – based on actual consumption and actual electricity emission factor:

Electricity meters will be installed in order to measure $EC_{PJ,j,y}$.

$EF_{EL,j,y}$ will be estimated following the approach below:

Where:

$EF_{EL,j,y}$ = Emission factor for electricity generation for project emissions in year y (tCO_2/MWh)

$FC_{n,i,t}$ = Quantity of fossil fuel type i fired in the captive power plant n in the time period t (mass or volume unit)

$NCV_{i,t}$ = Average net calorific value of fossil fuel type i used in the period t (GJ / mass or volume unit)

$EF_{CO2,i,t}$ = Average CO2 emission factor of fossil fuel type i used in the period t (tCO_2 / GJ)

$EG_{n,t}$ = Quantity of electricity generated in captive power plant n in the time period t (MWh)

i = are the fossil fuel types fired in captive power plant n in the time period t

j = Sources of electricity consumption in the project

n = Fossil fuel fired captive power plants installed at the site of the electricity consumption project source

t = Time period for which the emission factor for electricity generation is determined (see further guidance below)

Three types of fossil fuels are used in the project: associated gas, diesel and crude oil. Quantities of all three types ($FC_{n,i,t}$) will be monitored and appropriate systems will be put in place to measure their amouns. NCV of associated gas will be monitored. NCVs of diesel (42.3 TJ/Gg) and crude oil (43.0 TJ/Gg) are taken from "2006 IPCC Guidlines for National Greenhouse Gas Inventories, Volume 2: Energy", Table 1.2 and will not be measured i.e. are unchanged over the crediting period. Emission factor of associated gas is applied as for methane as per the methodology recommendation. Emission factors of diesel (74.1 tCO_2/TJ) and crude oil (73.3 tCO_2/TJ) are taken from "2006 IPCC Guidlines for National Greenhouse Gas Inventories, Volume 2: Energy", Table 1.4 and will not be measured i.e. are unchanged over the crediting period.
Quantity of electricity consumed will be measured and an appropriate monitoring system will be put in place.

Leakage

Following AM0009, Version 04, no leakage emission is considered.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	**$EF_{CO2, Methane}$**
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor for methane
Source of data used:	The Energy Information Administration (EIA), Department of Energy, USA <http://www.eia.doe.gov/oiaf/1605/coefficients.html> presents the default emission factor of 115.258 pounds of CO2 per million BTU.
Value applied:	49.55 tCO_2/TJ
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value suggested by the methodology applied.
Any comment:	---

Data / Parameter:	**$EF_{EL,j,y}$**
Data unit:	tCO_2/MWh
Description:	Emission factor for electricity generation for source j in year y
Source of data used:	Methodological tool "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 01), page 8, Option B2.
Value applied:	1.3
Justification of the choice of data or description of measurement methods and procedures actually applied :	For the purpose of estimation only the most conservative value is applied following tool recommendations.
Any comment:	---

B.6.3. Ex-ante calculation of emission reductions:

Baseline emissions

$$BE_y = V_{F,y} \cdot NCV_{RG,F,y} \cdot EF_{CO2,Methane}$$

Where:

BE_y = Baseline emissions during the period y, (tCO2e)

$V_{F,y}$ = Volume of total recovered gas measured at points F in Annex 5, after pre-processing and before the part of the recovered gas may be used on-site, during the period y, (Nm^3)

$NCV_{RG, F, y}$ = Net calorific value of recovered gas measured at points F in Annex 5 during the period y, (TJ/Nm3)

$EF_{CO2, methane}$ = CO2 emission factor for methane (tCO2/TJ)

Project emissions

PEy = $PE_{CO2,elec,y}$

The approach 1 is used for the purpose of estimation of project emissions while the Approach 2 for calculation of real emissions might be applied as described earlier.

Emission factor for electricity ($EF_{EL,j,y}$) is assumed as per the tool recommendation as 1.3 tCO_2/MWh.

Leakage

Following ACM0009, Version 04, no leakage emission is considered.

Emission reductions

Emission reductions are calculated as follows:

$ER_y = BE_y - PE_y$
Where:

ER_y = Emission reductions in the period y, (t CO_2e)
BE_y = Baseline emissions in the period y, (t CO_2e)
PE_y = Project emissions in the period y, (t CO_2e)

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emissions (tonnes of CO2e)	Estimation of baseline emissions (tonnes of CO2e)	Estimation of leakage (tonnes of CO2e)	Estimation of overall emission reductions (tonnes of CO2e)
From 2012-01-01 to 2012-12-31	33,417	215,114	–	181,697
From 2013-01-01 to 2013-12-31	30,825	197,928	–	167,102
From 2014-01-01 to 2014-12-31	25,270	162,277	–	137,007
From 2015-01-01 to 2015-12-31	20,146	129,472	–	109,326
From 2016-01-01 to 2016-12-31	16,577	106,545	–	89,968
From 2017-01-01 to 2017-12-31	14,340	92,068	–	77,728
From 2018-01-01 to 2018-12-31	11,601	74,519	–	62,918
From 2019-01-01	10,735	68,785	–	58,050

to 2019-12-31				
From 2020-01-01 to 2020-12-31	8,754	56,108	–	47,353
From 2021-01-01 to 2021-12-31	7,218	46,262	–	39,044
Total (tonnes of CO2e)	**178,883**	**1,149,077**	–	**970,194**

B.7. Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	**$V_{F,y}$**
Data unit:	Reported as standard (Normal) m^3 (Nm3) at 15 °C and 1.01325 bar (international gas reference conditions). Measurements in Standard Cubic Feet (SCF, 60 °F and 1.01325 bar) converted to Nm3 by multiplying with 0.0283719.
Description:	Volume of total recovered gas measured at point F in Figure No. 3, after pre-processing and before the part of the recovered gas may be used on-site, during the period y.
Source of data to be used:	Continuous flow measurement, using a Coriolis Flow Meter, which is compose of: (i) Coriolis Flow Sensor, 4" RF CL150# 316L SS, CL 1 DIV 1 GR C,D. integral core processor, Nema 4X, 1/2" npt connection, calibration: 0,10% mass flow & 0,5 kg/m3 density and (ii) Coriolis Flow Transmitter, 4-wire remote 35 DIN rail,Class I, Div. 2, Groups A, B, C, D, 19.2 to 28.8 Vdc, outputs: one mA, two configurable I/O channels & RS-485.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See values applied in the spreadsheet attached to this PDD.
Description of measurement methods and procedures to be applied:	Data shall be measured using calibrated Coriolis Flow Meters that will be installed at point F in Figure 3, i.e. prior to use the gas for on-site power generation. Every income line of gas, both as Jenbacher and Waukesha generators, it will have a Coriolis Flow Meter which transmit the gas flow (mass flow) to the Flow Computer via Modbus communication. The Flow Computer is a computer that calculated with high accuracy the volumetric flow gas. Performs this calculation using the mass flow delivered by the Coriolis Flow Meter and the Standard density value that is obtained from the gas composition provided by the on-line chromatograph. This signal is sent to SCADA G&E through the Ethernet. The data is measured continuously and is recorded and stored automatically and continuously.

QA/QC procedures to be applied:	The most significant advantage of Coriolis meters is high accuracy under wide flow ranges and conditions. Because Coriolis meters measure mass flow directly, they have fewer sources of error. At normal conditions, it is expected a flow rate accuracy rating of +/- 0.74 %. Instrumentation will be calibrated in line with industry standards and relevant laws, at least every 12 months. Maintenance will be done in accordance with the operational manual of the corresponding Original Equipment Manufacturer.
Any comment:	---

Data / Parameter:	$NCV_{RG,F,y}$
Data unit:	Reported as TJ/Nm3. Results from compositional analysis in unit BTU/lb. converted to TJ/Nm^3.
Description:	Net calorific value of recovered gas measured at point F in Figure 3 during the period y
Source of data to be used:	On-line Gas Chromatograph and configuration software included, 120Vac 60 Hz, 1 streams, sample probes 10", Material 316ss, TDC, 10 PPM min. concentration. Continuous measurement.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	According to measurements delivered by the chromatograph
Description of measurement methods and procedures to be applied:	Analysis will be performed in conjunction with measurement of the volume of recovered gas at point F. Samples are taken at point F in Figure 3, i.e. prior to use the gas for on-site power generation. The data is measured continuously and is recorded and stored automatically and continuously.
QA/QC procedures to be applied:	Analyzers are of international standard. Parameters will be measured on-line, chromatograph will be calibrated in line with industry standards and relevant laws, at least every 12 months. System accuracy: +/- 1% for components with measured ranges >5% +/- 2% for components with measured ranges =< 5%. Maintenance will be done in accordance with the operational manual of the corresponding Original Equipment Manufacturer.
Any comment:	---

Data / Parameter:	$EC_{PJ,j,y}$
Data unit:	MWh/yr
Description:	Quantity of electricity consumed by the project electricity consumption source j in year y
Source of data to be used:	Depending on approach 1 or 2, this will either be calculated based on installed capacity and actual load or measured directly.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See values applied in the spreadsheet attached to this PDD.

Description of measurement methods and procedures to be applied:	The data will be collected continuously and aggregated at least yearly. The data is measured continuously and is recorded and stored automatically and continuously.
QA/QC procedures to be applied:	In case of approach 1, no maintenance or calibration is required. In case of approach 2, calibration will be done in line with appropriate industrial standards and relevant laws, at least every 12 months. Electricity meter is revenue grade, 0.5 or better. Maintenance will be done in accordance with the operational manual of the corresponding Original Equipment Manufacturer.
Any comment:	---

Data / Parameter:	**FCn,i,t**
Data unit:	kg or m^3
Description:	Quantity of fossil fuel type i fired in the captive power plant n in the time period t
Source of data to be used:	If approach 2 is chosen, then the data will be taken from mass measurements of fuels consumed.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A as approach 1 has been chosen for the purpose of estimating project emissions in this PDD.
Description of measurement methods and procedures to be applied:	Depending on the fuel used, measurement can happen via flow meters, purchase invoices and other appropriate methods. Monitoring frequency will be applied appropriately the type of measurement. In case of flow/mass meters - the data is measured continuously and is recorded and stored automatically and continuously. In case of the data is based on purchase invoices – as soon as the invoice is available.
QA/QC procedures to be applied:	In case of approach 1, no maintenance or calibration is required. In case of approach 2, calibration will be done in line with appropriate industrial standards and relevant laws, at least every 12 months. Accuracy level will be in line with commonly used in industry or better. Maintenance will be done in accordance with the operational manual of the corresponding Original Equipment Manufacturer.
Any comment:	---

Data / Parameter:	**$EG_{n,t}$**
Data unit:	MWh
Description:	Quantity of electricity generated in captive power plant n in the time period t
Source of data to be used:	If approach 2 is chosen, then the data will be taken from electricity meters.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	N/A as approach 1 has been chosen for the purpose of estimating project emissions in this PDD.

Description of measurement methods and procedures to be applied:	The data will be collected continuously and aggregated at least yearly. The data is measured continuously and is recorded and stored automatically and continuously.
QA/QC procedures to be applied:	In case of approach 1, no maintenance or calibration is required. In case of approach 2, calibration will be done in line with appropriate industrial standards and relevant laws, at least every 12 months. Electricity meter is revenue grade, 0.5 or better. Maintenance will be done in accordance with the operational manual of the corresponding Original Equipment Manufacturer.
Any comment:	---

Data / Parameter:	**$EN_{aux,y}$**
Data unit:	MW
Description:	Nominal capacity of the auxiliary equipment used by the gas-based electricity generators
Source of data to be used:	If approach 1 is chosen, then the data will be taken from the capacity listed on the nameplate of the each installed unit of auxiliary equipment that is used by the gas-based generators in year y
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3,711
Description of measurement methods and procedures to be applied:	The data will be collected yearly based from the auxiliary units that have been in operation during the year.
QA/QC procedures to be applied:	In both cases of approach 1 or 2, no maintenance or calibration is required.
Any comment:	This parameter will not be monitored if monitoring approach 2 is adopted.

Data / Parameter:	**$EG_{gas,j,y}$**	
Data unit:	MWh	
Description:	Quantity of electricity generated by gas-based energy generators j in the year y	
Source of data to be used:	If approach 1 is chosen, then the data will be taken from electricity meters at gas-based energy generators.	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Year	MWh
	2012	422536
	2013	389764
	2014	319520
	2015	254730
	2016	209605
	2017	181321
	2018	146692
	2019	135734
	2020	110692

	2021 91266
Description of measurement methods and procedures to be applied:	The electricity generation data will be collected continuously by the integrated SCADA (Supervisory Control and Data Acquisition) with online real-time data access at the generator terminals. The data is measured continuously and is recorded and stored automatically and continuously.
QA/QC procedures to be applied:	In case of approach 1, no maintenance or calibration is required. In case of approach 2, calibration will be done in line with appropriate industrial standards and relevant laws, at least every 12 months. Electricity meter is revenue grade, 0.5 or better. Maintenance will be done in accordance with the operational manual of the corresponding Original Equipment Manufacturer.
Any comment:	This parameter will not be monitored if monitoring approach 2 is adopted.

Data / Parameter:	$EN_{gas,j,y}$
Data unit:	MW
Description:	Nominal capacity of gas-based energy generation equipment j (MW) in year y
Source of data to be used:	If approach 1 is chosen, then the data will be taken from the capacity listed on the nameplate of the each gas-based generation unit j in year y
Value of data applied for the purpose of calculating expected emission reductions in section B.5	61
Description of measurement methods and procedures to be applied:	The data will be collected yearly from the gas-based generation units that have been installed by the project activity.
QA/QC procedures to be applied:	In both cases of approach 1 or 2, no maintenance or calibration is required.
Any comment:	This parameter will not be monitored if monitoring approach 2 is adopted.

B.7.2. Description of the monitoring plan:

In order to ensure the successful implementation and operations of the CDM Project Activity, PETROAMAZONAS will setup a team to oversee the implementation of the Monitoring Plan. This includes making sure that proper monitoring equipment is specified and installed whereby this must go hand in hand with the corresponding operations, measurement, registration and maintenance procedures (together referred to as the Monitoring Plan). The CDM Monitoring Plan will be integrated into PETROAMAZONAS´ Operations & Maintenance Procedure.

The Monitoring Plan consists of six key elements to ensure that: i) Monitoring Plan complies with CDM Project Activity requirements, ii) relevant data is collected, iii) data is collected based on industry

standards, iv) monitoring consistency during operations / measurement, v) proper operations and maintenance procedures and vi) assure that is it "user friendly" to both operators and a DOE.[10]:

A. Data collection task:

Data needs to be collected for monitoring the Project Activity whereby the collected data must comply with minimum requirements as laid out in Section B.7.1. For every relevant parameter: recording and filing instructions must be issued thereby making sure indicated parameter are recorded and registered accordingly (physical and digital).
Measuring points F are indicated in the Annex 5. These points will be supplied with flow meters and chromatographs as stated in the section B.7.1.

B. Equipment calibration task:

For each instrument used for the purposes of the CDM Monitoring Plan, a separate calibration procedure shall be defined. This includes definition of any relevant calibration standards, guidance from equipment supplier, accuracy of equipment and means of calibration to ensure its compliance with the Monitoring Plan. All measurements shall be conducted with calibrated measurement equipment according to relevant industry standards.

C. Mechanism for data reconciliation:

Under the Monitoring Plan, PETROAMAZONAS shall also identify procedures, means and sources to verify / reconcile data obtained from the measurement devices/procedures. For example, fossil fuel quantity consumption needs to be crosschecked, reconciled or consolidated with multiple sources such as operators at power plants and the purchasing department in charge of procuring diesel for the power generation activity.
If a relative comparison between measuring devises will reveal anomalities i.e. out-of range values a calibration will be triggered immediately.

D. Storing data:

According to the AM0009 – Version 04, all data collected under the Monitoring Plan must be stored electronically for at least 2 years after the date of the corresponding crediting period. In order to meet this obligation, PETROAMAZONAS shall establish the means of storing the data (with corresponding back-up system) to ensure that the data can be accessed when required.

E. Emission reductions calculation and reporting:

A calculation and reporting format must be pre-established whereby, by feeding in the corresponding "on-line" data (data collected on a continuous basis whereby operators can see and evaluate trends and historic data), accurate and relevant crediting information can be obtained. The previous not only reduces the margin of error (either operating, measurement or calculation errors) considerably but also allows the

[10] Clean Energy Finance Committee, Mitsubishi UFJ Securities, "GHG Emission Reduction Monitoring & Reporting Guideline: A Practical Guideline for the Implementation of the Monitoring Plan and the Reporting of GHG Emission Reduction", Version E-1.0, December 2006.

stakeholders to get direct consolidated information ("on-line") required for the reporting and verification process. To support this activity PETROAMAZONAS is implementing an integrated SCADA (Supervisory Control and Data Acquisition) system.

PETROAMAZONAS will install all necessary meters and monitoring equipment and software to secure that all relevant data is collected, stored, processed and communicated accordingly. The calculation of emission reductions can be performed efficiently and accurately using spreadsheet applications.

F. Training program and procedure compliance:

Prior to implementing the Monitoring Plan, it is important to develop a training program and an Operations Manual for operators and Project Activity Supervisors. Employees at the sites of the Project Activity shall be trained and equipped to perform their activities in line with monitoring requirements to ensure that relevant and accurate emission reduction data collection and processing takes place.

The data will be "on-line" and stored at CPF´s and EPF´s SCADA system. Additionally the information will be stored at PETROAMAZONAS´ headquarters in Quito. Data will be stored in compliance with monitoring requirements.

G. Management structure for the implementation of the monitoring plan:

A CDM Project Manager will be responsible for structuring and overseeing all the data collection activities, measurements, calibration and reporting in line with the Monitoring Plan for the Project Activity. A specific work / reporting flow diagram will be developed indicating which parties need to be involved and to what degree for each activity. The figure below provides a preliminary graphical representation of the Management Structure for the implementation of the Monitoring Plan:

Figure No. 5: Schematic illustration of the management structure for the implementation of the monitoring plan

The CDM Supervisor is responsible for making sure that each party understands and abides by the procedures laid out in the Monitoring Plan. Additionally, after verifying that collected relevant data is accurate, this is processed accordingly to issue the Monitoring Report. Apart from monitoring and auditing internal activities and procedures to assure accurate reporting he must also monitor external factors, such as regulatory issues, that could have an impact on the CDM Project Activity and corresponding Monitoring Plan.

The OGE Project Director or Maintenance Manager will review the whole process before approving and formally issuing the corresponding Monitoring Report.

B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

This Baseline Study was completed on the 5th of October 2009 using methodology AM0009 Version 4 was used. The Baseline Study was prepared "in-house" by Berend van den Berg (Project Director) and David Neira (CDM Specialist) with the support of information supplied by TECNA.

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

12.02.2009

C.1.2. Expected operational lifetime of the project activity:

10 years

C.2. Choice of the crediting period and related information:

C.2.1. Renewable crediting period:

C.2.1.1. Starting date of the first crediting period:

Not applicable

C.2.1.2. Length of the first crediting period:

Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01.01.2012

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

The Project Activity is regulated under the following environmental legal framework:

- "Law on Environmental Management"
- "Law on Prevention and Environmental Contamination Control"
- "Environmental Rules and Regulations for Electrical Activities"
- "Unified text on Secondary Environmental Legislation, particularly the book VI and its respective annexes / specifications applicable to the electricity sector".

The Power Generation Systems fall under the Environmental License Nº 044, 042 y 075, respectively. Additionally, during the year 2008 the Environmental License Nº 014 was issued for the New Power Plant running on crude oil in EY whereby this process required new Environmental Impact Assessment (EIA) that was concluded and published on the 30th of May 2008 by Communication DE-08-1070 issued by the "National Electricity Council" (CONELEC).

With the objective to ensure compliance of PETROAMAZONAS' environmental management procedures with the requirements laid out in the "Environmental Rules and Regulations for Electrical Activities" (Artículo 13 y Artículo 37, Literal b), PETROAMAZONAS is subject to periodical Environmental Audits (referred to as "Auditorías Ambientales Internas (AAI)") by the Ministry of Environment. In line with this requirement, an audit was done in March 2009 for the environmental management procedures related to power generation activities in Block 15 in 2008.

The environmental audit focused on operational conditions of the auto-generation system and the surrounding areas by measuring and analyzing social-environment impacts, condition of power generation equipment and related infrastructure, and potential environmental impact. By means of site visits and corresponding monitoring, air quality, magnetic fields, noise level, etc. were measured and quantified. Further analysis was then undertaken to determine compliance of PETROAMAZONAS operations with applicable environmental norms for the electric sector.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

In line with the terms of reference issued by CONELEC for environmental auditing, the following parameters were monitored[11]:

- Discharge of effluents
- Solid Waste Management
- Emissions
- Air Quality
- Noise Level

[11] ENTRIX "Internal environmental audit to current power generation systems at Indillana, Limoncocha and Yanaquincha and Eden Yuturi Field", March 2009.

- Electromagnetic fields
- Social aspects

During the environmental auditing process, 108 items were reviewed whereby 94.4% of the reviewed items were found to be in compliance, which demonstrates that in general PETROAMAZONAS has a very acceptable level of environmental management. Particularly concerning to health, safety, training, procedures, equipment and response capacity to emergencies PETROAMAZONAS scores above average.

- Air Emissions:

As result of the fieldwork, certain problem areas were detected concerning air emissions. The monitoring results show that of the 301 sources monitored in ILYP 18.60% exceed the established limits whereby in EY, of the 64 sources monitored, 31.25% exceed the limits. The Project Activity will play an important part in improving the air pollution from the Block 15 and Block 31. PETROAMAZONAS carries out scheduled and preventive maintenance according to the Operations Manuals of the OEMs.

- Noise Levels:

The noise level within the facility boundary limits comply with regulatory norms whereby the noise level to which the workers are exposed is not high. In general workers seldom enter the power generation engine hall (where most of the noise is concentrated) and in these cases only for short periods of time and with required personal safety equipment and ear protection.

However, with the regards to noise impact outside the facility boundaries it was determined that certain noise mitigation work is required. Part of the work consists in installing additional silencers in series with existing silencers and installing noise absorption walls to mitigate noise from the engines. Additionally, in ILYP most of the gas generating equipment will be installed in noise mitigation enclosures.

- Social Aspects:

The audit concludes that there is a good level of compliance in terms of social aspects. The report concludes that PETROAMAZONAS has complied with the terms and conditions laid out in community agreements in the areas of influence of the Block 15 and Block 31, and that no breaches of compliances have been registered. Nonetheless, the report recommends for PETROAMAZONAS to disclose more openly the content of the agreements in place to the local communities, thereby helping the communities to understand the scope and timelines of the agreements.

The recommendations laid out in the audit report are geared towards improving specific environmental management aspects such as air emissions and social aspects. The OGE Project should be considered as an important means to mitigate environmental impact such as air and noise emissions. Nevertheless, the recommended corrective actions outlined in the Environmental Audit, must be implemented within the indicated timelines with the clear objective to overcome the listed breaches in compliance.

As indicated above, the Project Activity will mitigate two key issues addressed in the Audit Report, namely:

- Air Quality: the air quality will improve significantly when optimizing flare gas for power generation, namely, not only will flaring be reduced to the minimum but using associated gas as a

fuel for power generation, but, air emissions as such as lower when generating with gas then with liquid fuel.

- Noise Impact: Centralizing power generation through installation of new power distribution networks will reduce the number of power generation units.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

With the objective to get corresponding feedback from national and local stakeholders regarding the Project Activity, PETROAMAZONAS established a campaign to disclose and communicate the scope and objectives of the Project Activity putting special emphasis on the potential to mitigate Climate Change. To raise the awareness of the Project Activity, its scope and objectives, and subsequently obtain feedback, PETROAMAZONAS used various instruments whereby the first tool was publishing the PIN on its website.

Local written media, such as corporate news magazine, industry- and environmental magazines and national newspapers, were also used to create awareness of the Project Activity.

Additionally various platforms were used to present the Project Activity on the National and International scene such as:

- Carbon Expo 2009 in Barcelona Spain.
- Latin American Carbon Forum 2009 in Panama City.
- Oil&Power Conference in Quito Ecuador in 2009.

Throughout the whole process the Project Activity has been presented to all the corresponding Government Entities such as the President of the Republic of Ecuador, the "Ministry of Non-Renewable Natural Resources", the "Ministry of the Environment", the "Ministry of Finance", the Ministry for Planning and Development", SENPLADES; PETROECUADOR, etc.

Finally, PETROAMAZONAS presented the Project Activity to various local stakeholders with the purpose of giving them a chance to voice their concerns and opinions. Two separate meetings were conducted at Limoncocha on 27/01/2010 and at Eden Yuturi on 28/01/2010 project sites. During these meetings it was agreed upon that frequent meetings should be held to keep the local stakeholder updated on the Project Activity. The local stakeholders in this case consisted of:

- Leaders of all Communities in the area of influence.
- Representatives of Indigenous associations.
- Local authorities.
- Other key figures such as teachers, doctors, etc.

E.2. Summary of the comments received:

In general the Project Activity was positively received by both local- and national stakeholders, largely due to the fact that they perceived that the Project Activity will provide a positive impact on global climate change.

On a national level the Project Activity has been recognized as a project of "National Interest" whereby periodic updates need to be given to the President of the Republic of Ecuador. Part of this exercise consist of updating information on the website of the SIGOB (System for Democratic Governance) http://www.sigob.gov.ec/metas/main/consulta/default.asp whereby most of the information is available to the public and certain specific information available only to authorized authorities.

The response from the local stakeholders was also positive since they perceive the flare as a threat to their health and, most of all, they are very positive about the noise mitigation plan that is an integral part of the Project Activity. An extensive presentation was given to the local Stakeholders whereby they were given the opportunity to also express their concerns and recommendations. Below we lay out the key issues pointed out by the Local Stakeholders:

- Local Stakeholders want to get an update on the Project Activity on a periodic basis.
- They would appreciate it if the Project Activity is also presented in the schools.
- To the local Stakeholders it is essential that, to the extent possible, local labor is used for the Project Activity.

E.3. Report on how due account was taken of any comments received:

The stakeholder dialogues served the purpose of creating a platform through which stakeholders can continue interacting with PETROAMAZONAS regarding their concerns and questions regarding the Project Activity. The Project Activity was looked upon positively by the stakeholders, and this motivates PETROAMAZONAS to put emphasis on the following issues:

- Use the Project Activity as a platform to engage with the local stakeholders on a continuous basis.
- Engage the company to evaluate the option of reserving a certain percentage of CDM- based income to finance local sustainable community projects.
- Affirm its commitment to transparency in its communications with the local stakeholders.
- PETROMAZONAS is committed, as it has always been, to using local labor where possible.

Participant lists, minutes of meeting, photographic reports, etc. from the stakeholder meetings were used to document the proceedings.

Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Not applicable for this Proposed Project activity.

Annex 3

BASELINE INFORMATION

National Circumstances

Background

Although Ecuador is a crude oil exporter, national refining capacity of fossil fuels does not supply current demand. The general refining statistics show that out of 62.9 million barrels of derivatives produced by the refineries in 2006 consisted of 15.6% Fuel Oil #4, 19.2% Diesel #2, 18.1% Gasoline's, 3.4% LPG, 25.1% other, and 18.7% correspond to residues.

The produced diesel has a high sulfur content, which not only generates accelerated deterioration of the equipment but also results in a higher environmental impact. The LPG production is limited, which consequently forces Ecuador to import this fuel to meet internal demand. As LPG is sourced from open markets cost are elevated which prevents the build up of any material reserves to mitigate contingencies.

The internal supply does not meet the national demand for high-octane naphtha and diesel fuel and subsequently these fuels have to be imported at international prices. Given the imbalance between internal demand and refining capacity, the country had to purchase 25.9 million barrels of derivates in the year 2006 and only exported 13.6 million barrels (mainly HFO) with unfavorable price differential[2].

The average cost of imports in the year 2007 was 83 $/bbl versus an export price of 55.8 $/bbl. This result has a direct negative impact on the derivative trade balance, which tilted this toward negative values. Fuel imports between the 2004 and 2006 totaled USD 4.255 million while exports of crude oil derivatives over the same period totaled USD 1.404 million leaving a deficit to PETROECUADOR of USD 2.851 millions, a trend that has continued and increased[2].

As indicated in the "*Strategic policies to change the energy matrix, May 2008*"[2 and 12], associated gas is a key energy source that has not been properly tapped in Ecuador. It is estimated that around 1.25 million cubic meters of associated gas have been flared due to a lack of pipelines, compression facilities, and gas treatment plants and, due to a general lack of funds and commitment.

[12] Former Ministry of Energy and Mines, "Energy Agenda 2007-2011: Towards a sustainable energy system", June 2007.

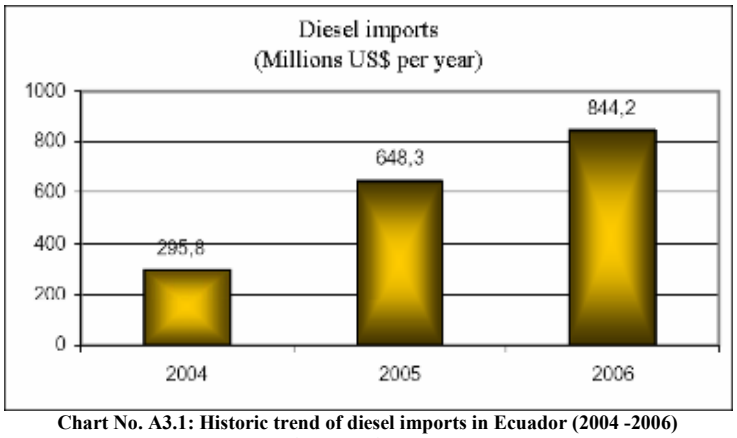


Chart No. A3.1: Historic trend of diesel imports in Ecuador (2004 -2006)
Source: Agenda Energética 2007 - 2011, 2007.

Utilization of associated gas in Ecuador is hindered by lack of incentives in The Hydrocarbon Law and a general shortage of funds, which leads to available funds being channeled to oil production projects.

Lack of funds and infrastructure to develop natural gas reserves or capture associated gas has contributed significantly in Ecuador's trade deficit. For example, natural gas could provide an alternative to imported LPG, which is mostly used for residential cooking and heating. In addition, increased natural gas production could supply more gas-fired power plants, replacing diesel, bunker C or crude oil generators[13]. Figure No. 6 presents the main sources of energy in Ecuador, illustrating that natural gas and/or associated gas accounts only for a small share of supply in the country's energy balances.

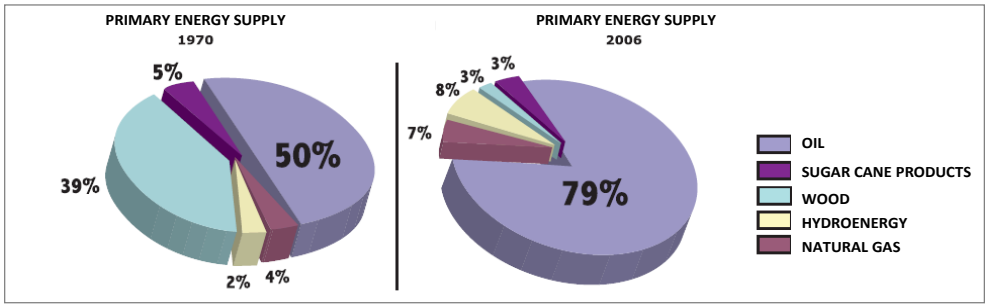


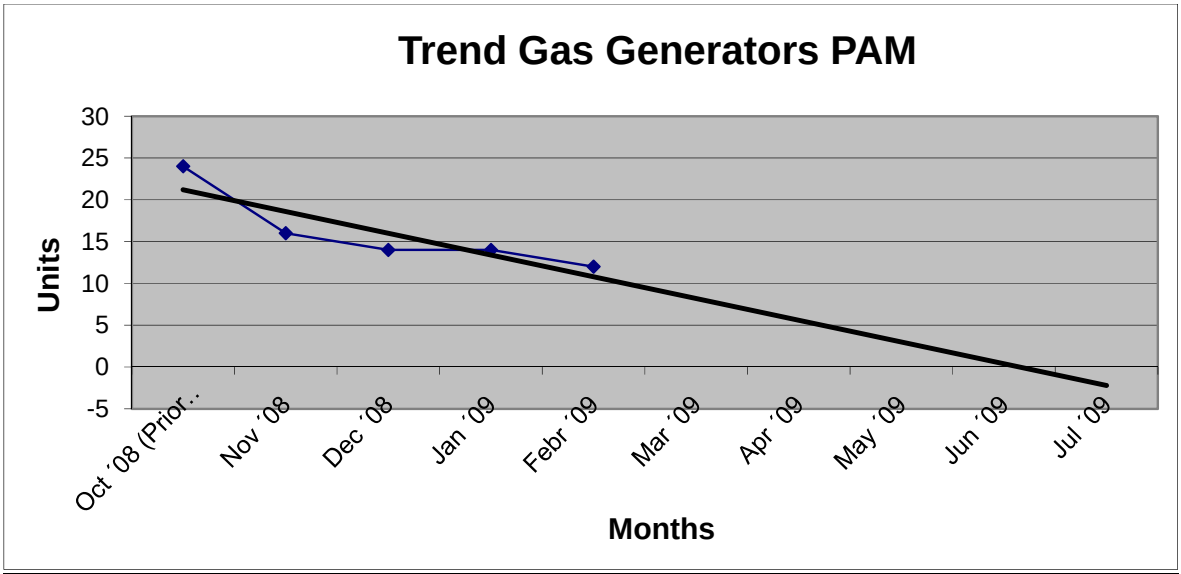
Fig. No. A3,1: The Ecuadorian Energy Matrix (1970, 2006)
Source: Ministry of Electricity and Renewable Energy, "Políticas y Estrategias para el Cambio de la Matriz Energética en el Ecuador", May 2008.

Local Petroamazonas Circumstances

As of October 2008 Petroamazonas operated 24 associated gas generators. In February 2009 only 12 (and only 11 early in March 2009) are left in operation i.e. within 5 months time 50% of generators were taken out from operation. A projection was made based on historical data which shows that most probably no associated gas power generators would be in operation in June 2009, please refer to "Trend Gas Generation Units PAM.xls" and the graph "Trend Gas Generators PAM" below. The reason for such a

[13] Energy Information Administration (Official Energy Statistics from the U. S. Government), "Country Brief Analysis: Ecuador Energy Data, Statistics and Analysis - Oil, Gas, Electricity, Coal", April 2008.

rapid decrease of power generation based on associated gas is very high unreliability and instability of the equipment. Critical deteriorating technical condition of equipment which used associate gas prior to the Project Activity is confirmed by several third-party organizations which inspected the project sites; please refer to "Certification ARCOLANDS Waukesha.pdf", "Customer Copy- Work report Oxy _Wartsila document_.pdf", "Scrapped Gas Generators Before Project Activity.pdf", "TECNA previous Project Activity ILYP 2008.pdf". Finally, prior to the Project Activity Petroamazonas had clear intention to replace all gas power generators with more reliable and easier operated diesel and crude oil generators and invested nearly 50 million USD into such equipment; please refer to "POs Diesel Power Generation Units ILYP.pdf", "POs Crude Oil Power Generation Units EPF.pdf".



Annex 4

MONITORING INFORMATION

Not applicable

Annex 5

BACKGROUND INFORMATION ON PROJECT ACTIVITY

In order to avoid misunderstanding of information in this annex, please note that all equipment which is shown in charts below for the situation prior to the project would have been taken out at least by June 2009 in the absence of the project activity. In other words, in the baseline all associated gas would be flared and the equipment existed and utilized associated gas prior to the project implementation would have been scrapped and replaced with diesel and crude oil based equipment. Critical deteriorating technical condition of equipment which used associate gas prior to the Project Activity is confirmed by several third-party organizations which inspected the project sites; please refer to "Certification ARCOLANDS Waukesha.pdf", "Customer Copy- Work report Oxy _Wartsila document_.pdf", "Scrapped Gas Generators Before Project Activity.pdf", "TECNA previous Project Activity ILYP 2008.pdf". Moreover, according to the historical information (please refer to "PAM Timeline for the replacement of old generators") for the period from October 2008 to February 2009 (so, just in 5 months) more than 50% of associated gas power generators were taken out from the operation due to technical faults. Finally, prior to the Project Activity Petroamazonas had clear intention to replace all gas power generators with more reliable and easier operated diesel and crude oil generators and invested nearly 50 million USD into such equipment; please refer to "POs Diesel Power Generation Units ILYP.pdf", "POs Crude Oil Power Generation Units EPF.pdf".

It should be noted that project implementation consists of three main phases. Where the first phase includes the recovery and adaptation of gas equipment existed prior to the Project Activity and that is possible and/or reasonable to overhaul; this equipment in the absence of the project would be scrapped at least by commissioning of the first unit of the Project Activity or even earlier. Phases 2 and 3 include installation of new equipment with the purpose of utilization of all associated gas available in the fields.

For more details on that please refer to the Section B of the PDD and to the table below.

STATUS POWER GENERATION WITH GAS PRIOR TO AND AS A RESULT OF PROJECT ACTIVITY

This table includes information about all gas based generators which are used in the project activity i.e. installed before the project and overhauled (kept running) due to the project and newly installed.

No.	Model	TAG	Location	Existing or new as of the project activity start date	Nominal Capacity (kW)	Capacity as of the project start date (kW)	Phase	Planned Operating Capacity after the project implement ation (kW)	Observations
1	VHP 7100	MG 102	CPF	Existing	1 000	-	1	800	MG 102, MG 103 and MG 301-3 were purchased second hand by previous operator (OXY) whereby they found out that these engines originally were designed to run on diesel and had been coverted to gas engines. **These engines were NOT operational when the Project Activities started and were stationed 2 x Laguna and 1 x Jivino A (NOT operational).** Considerable investments were made on the part of PAM to get these engines operational (we have contract documents supporting the total amount of investment requiered to put these units into operations). The MG 101-9 was operating but only at 300 kW whereby it was at the point of coming to a halt and would be definitely scraped by June 2009.
2	VHP 7100	MG 103	CPF	Existing	1 000	-	1	800	
3	VHP 7100	MG 301-3	CPF	Existing	1 000	-	1	800	
4	VHP 7100	MG 101-9	CPF	Existing	1 000	300	1	800	
5	GE320	GE320 - GP 1	CPF	New	1 000	-	2	800	These have been contracted under the Project Activity whereby PETROAMAZONAS holds a purchase option.
6	GE320	GE320 - GP 2	CPF	New	1 000	-	2	800	
7	GE320	GE320 - GP 3	CPF	New	1 000	-	2	800	
8	GE320	GE320 - GP 4	CPF	New	1 000	-	2	800	
9	GE320	GE320 - GP 5	CPF	New	1 000	-	2	800	
10	GE320	GE320 - GP 6	CPF	New	1 000	-	2	800	
11	GE320	GE320 - 7	CPF	New	1 000	-	3	800	PETROAMAZONAS is in the process of purchasing these (most probably through a lease agreement with a purchase option).
12	GE320	GE320 - 8	CPF	New	1 000	-	3	800	
13	GE320	GE320 - 9	CPF	New	1 000	-	3	800	
14	GE320	GE320 - 10	CPF	New	1 000	-	3	800	
15	VHP 5900	MG 2101-1G	Limoncocha	Existing	750	250	1	600	**These six power generation units were operating under extreme critical deteriorated conditions** whereby PETROAMAZONAS was in the process of replacing these with diesel power generation equipment (part of the USD 17,000,000 used to purchase diesel generators). It is important to point out that the MG 21014G (future MG 2101-16G) suffered a fatal damage and is being replaced by a new engine. All these engines would definitely be scrapped by June 2009 in the absence of the project.
16	VHP 5900	MG 2101-2G	Limoncocha	Existing	750	250	1	600	
17	VHP 5900	MG 2101-3G	Limoncocha	Existing	750	250	1	600	
18	VHP 5900 (fatal damage)	MG 2101-4G** / 16 G	Limoncocha	Existing	1 000	250	3	800	
19	VHP 5900	MG 2101-5G	Limoncocha	Existing	750	250	1	600	
20	VHP 5900	MG 2101-6G	Limoncocha	Existing	750	250	1	600	
21	VHP 7104	MG 2101-11G	Limoncocha	New	1 200	-	1	960	None of these were in place prior to the Project Activity whereby the MG 2101-14G and 15G will replace the MG 2101-9G and 10G which are NOT suitable for asociated gas.
22	VHP 7104	MG 2101-12G	Limoncocha	New	1 200	-	1	960	
23	VHP 7100	MG 2101-13G	Limoncocha	New	1 000	-	2	800	
24	VHP 7100	MG 2101-14G	Limoncocha	New	1 000	-	2	800	
25	VHP 7100	MG 2101-15G	Limoncocha	New	1 000	-	2	800	
26	GE 320	GE320 - 11	Yamanunka	New	1 000	-	2	800	See observation GE320-7, 8, 9 and 10.
27	GE 320	GE320 - PAM 1	Yamanunka	New	1 000	-	2	800	Were purchased by PETROAMAZONAS whereby the generators in Yamanunka entered into operations in 2010 and the ones in Paka Sur will enter into operations in 2011.
28	GE 320	GE320 - PAM 2	Yamanunka	New	1 000	-	3	800	
29	GE 320	GE320 - PAM 3	Paka Sur	New	1 000	-	2	800	
30	GE 320	GE320 - PAM 4	Paka Sur	New	1 000	-	2	800	
31	18V34SG	ZAN 103	Eden Yuturi	Existing	4 500	2 500	3	3 600	These engines were operating with asociated gas without propper gas treatment and were at a point of having to be taken out of service. Today a large investment is being made to install i) compressors, ii) separators, iii) gas treatment plan and iv) gas storage. Bear in mind that Wartsila indicated from "day one" to the previous operator that **these engines were NOT designed to run on asociated gas**. These would definitely be taken out by June 2009.
32	18V34SG	ZAN 105	Eden Yuturi	Existing	4 500	2 500	3	3 600	
33	18V34SG	ZAN 107	Eden Yuturi	Existing	4 500	2 500	3	3 600	
34	18V32LN	ZAN 100	Eden Yuturi	New	5 000	-	2	4 000	These are crude engines that are being converted to gas / crude engines whereby part of the payments will be made with the income from CERs.
35	18V32LN	ZAN 102	Eden Yuturi	New	5 000	-	2	4 000	
36	18V32LN	ZAN 104	Eden Yuturi	New	5 000	-	2	4 000	
37	18V32LN	ZAN 106	Eden Yuturi	New	5 000	-	2	4 000	
				Total	**62 650**	**9 300**		**50 120**	**80%**

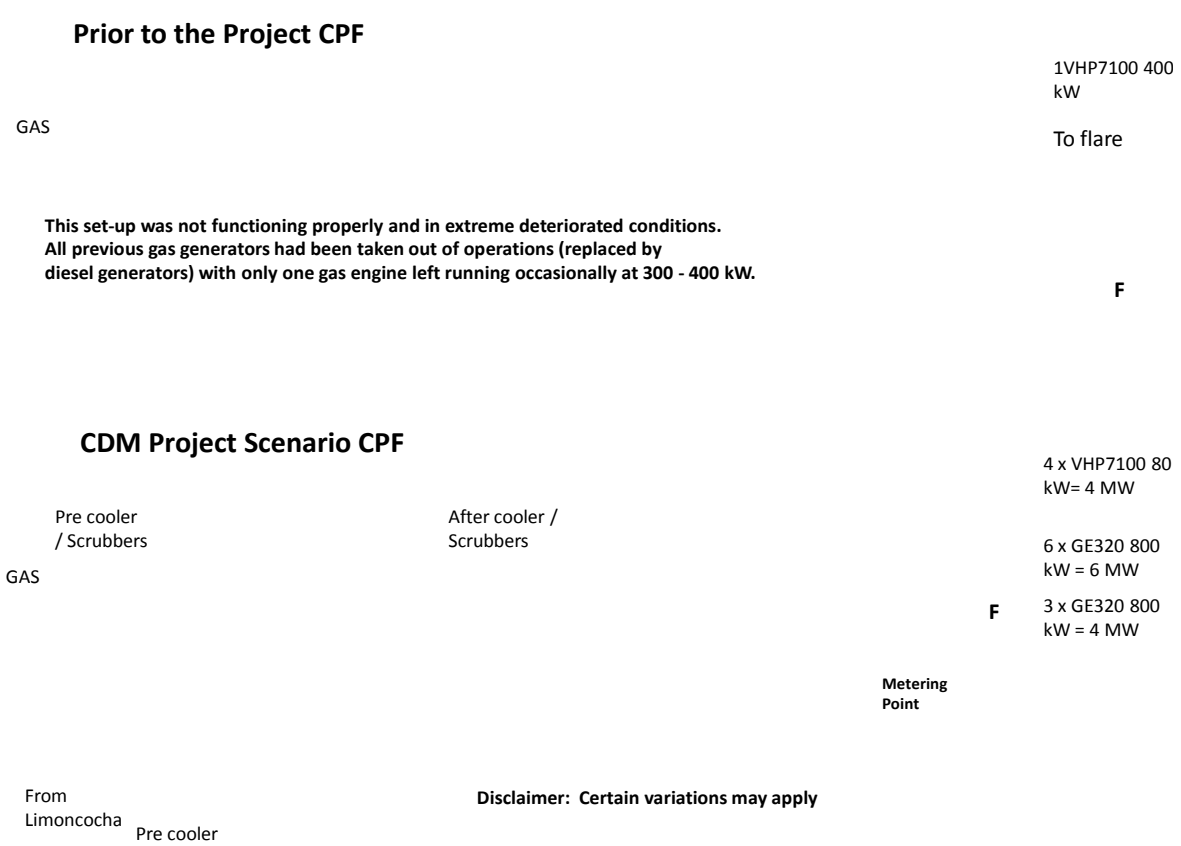
Central Processing Facilities (CPF)

Gas Handling:

- Re-engineering Gas Handling Facility
- Install additional Gas Compression Capacity.
- Install Treatment System.
- Incorporate Gas Storage Facility to compensate gas delivery fluctuations.

Electric Power:

- Install Gas Power Generation System
- Incorporate Centralized Power Distribution System (13.8 kV) including Substations.
- Convert engine driven pumps (burning diesel) to electric motor driven pumps
- Transmission lines to Jivino B, Jivino F, Itaya, Limoncocha, Palmar Oeste and Yanaquincha



Limoncocha Processing Facilities (LPF)

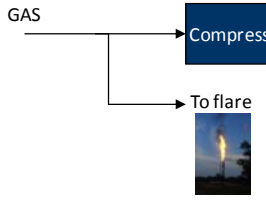
Gas Handling:

- Re-engineering Gas Handling Facility
- Install Gas Treatment Equipment
- Install additional Gas Compression Capacity
- Incorporate Gas Storage Facility

Electric Power:

- Upgrade Existing Power Generation Facility (6 x VHP 5900 en extreme deteriorated conditions).
- Install Additional Power Generation Capacity
- New Centralized Power Distribution System (13.8 kV)
- Substations
- Convert engine driven pumps (burning diesel) to electric motor driven pumps
- Transmission line between CPF and Limoncocha
- Transmission lines between Limoncocha and Yamanunka

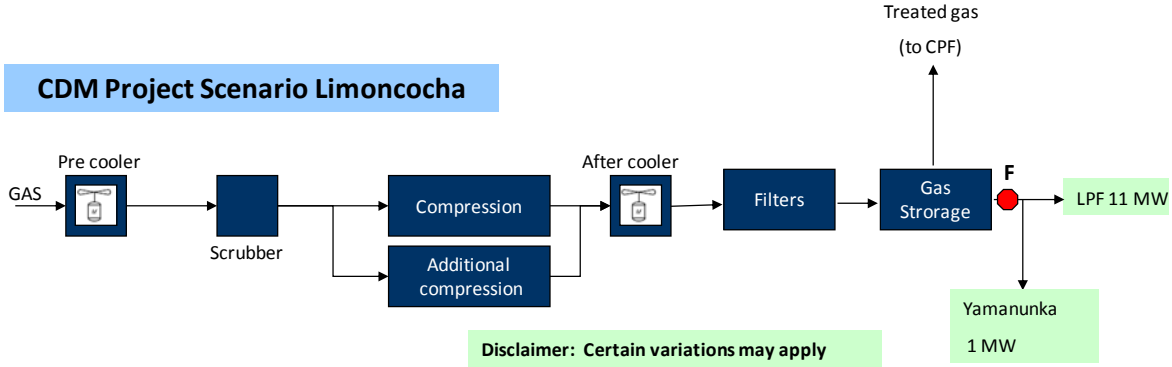
Baseline Scenario Limoncocha



• 6 x VHP 5900 gas power generation units (generation 250 kW each) were in extreme deteriorated conditions (one was scrapped lately due to a mechanical failure) whereby PETROAMAZONAS was in the process of replacing gas power generation units with diesel power generation units

•The existing set-up did not guarantee a stable power supply

CDM Project Scenario Limoncocha



Disclaimer: Certain variations may apply

• **Paka Sur** **Gas Handling:** ▪ Install Gas Compression System ▪ Install Gas Handling / Treatment System ▪ Install Gas Storage Facility **Electric Power:** ▪ Upgrade Existing Power Distribution System ▪ Install Power Generation Capacity	**Prior to the Project Paka Sur** GAS To flare **CDM Project Scenario Paka Sur** Pre Cooler After cooler **F** 2 GE320 800 kW = 2 MW GAS Scrubber **Disclaimer: Certain variations may apply**

• **Eden Yuturi**

Gas Handling:

- Install Gas Handing (Compression and Treatment) System
- Low Pressure Gas Gathering and Handling System
- Install Gas Storage Facility

Electric Power:

- Install Gas Treatment and Upgrade SG engines to allow for power generation with associated gas.
- Convert Crude Engines to Gas / Crude Engines

Prior to the Project Eden Yuturi (EPF)

Generation Plant (CGE)

• 4 x 18V32LN 6.0 MW = 30.0 MW (Crude oil).

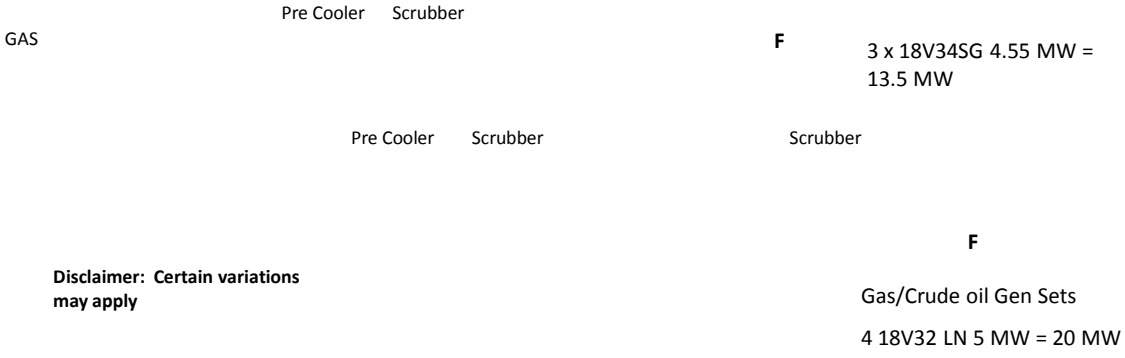
• 3 x 18V34SG 2.6 MW = 7.2 MW (Gas)

+

• SG engines NOT suitable to run on associated gas

• 4 x 18V32LN 7.5 MW = 30.0 MW (Crude oil)

CDM Project Scenario Eden Yuturi (EPF)



Disclaimer: Certain variations may apply

Prior to the Project Yamanunka

- No power generation with gas, no flaring.

CDM Project Scenario Yamanunka