NORTHERN FUEL PIPELINE TRANSPORTATION PROJECT, THAILAND

Document Prepared by Fuel Pipeline Transportation Limited (FPT) and ERM

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1 PROJECT DETAILS

1.1 Summary Description of the Project

The objective of "Northern Fuel Pipeline Transportation Project, Thailand" is to improve for more efficient liquid fuel transportation by implementing the liquid fuel pipeline transportation from Bangkok to the northern part of Thailand, which is to be executed by Fuel Pipeline Transportation Limited (FPT). The project enables reduction of GHG incurred from existing liquid fuel transportation, generated from diesel combustion of heavy trucks. Additional benefits include potential reductions of traffic congestion and road accidents.

The project activity is to install i) liquid fuel pipelines - with 12 and 14 inches in diameter, 576 kilometers in distance and approximately 9,000 million liters of fuel pipeline capacity - from Bang-Pa-In depot in Ayuthaya province, to Phichit depot, Phichit province and then to Lampang depot in Lampang province, ii) high-pressure pump stations iii) Phichit and Lampang depots. The fuel pipeline can transport liquid fuel of multiple products in one single line of pipeline. The Bang-Pa-In Depot acts as a starting point to transport liquid fuel. The project is expected to generate GHG emission at least reductions of 29,180 ton CO2e per year and 291,803 ton CO2 in 10 year crediting period.

The existing situation prior to the implementation of the project, the liquid fuel is transported from Bang-Pa-In depot in Ayuthaya province to the North of Thailand via heavy diesel-consuming trucks. After the project implementation, the liquid fuel of Bang-Pa-In depot in Ayuthaya province will eventually be transported to Lampang province, the North of Thailand, via liquid fuel pipeline.

This project can improve the cost efficiency of fuel transportation and mitigate environmental impacts, as the fuel pipeline transportation is a closed system, meaning it generates no environmental impacts compared to fuel transportation trucks in the status quo, which emits greenhouse gas. The Approved VCS Methodology AM110 – Shift in Transportation of Liquid Fuel – was applied to estimate the project's emission reductions. This project is expected to reduce 29,180 tCO2e/year. The implementation of the project "Northern Fuel Pipeline Transportation Project, Thailand" started with an Engineering Study in 2013. The project milestones are present as follows.

Table: Project Milestones

Date	Detail	Document Name
1 April 2013	Hiring Engineering Study Contract of Northern Fuel	Engineering Study Contract of Northern Fuel Pipeline Transportation, Thailand

	Pipeline Transportation, Thailand	
3 April 2013	Initial study by third party, which is Engineering Consultant- Index International Group, Co., Ltd.	The study on fuel consumption
29 August 2015	Conducting the feasibility study report by third party, which is Genetic Wealth Co., Ltd.	Feasibility study report document
1 September 2015	Hiring Environmental Impact Assessment (EIA) contract of Northern Fuel Pipeline Transportation Project (Bang Pa In to Lampang), Thailand with a consultancy company for EIA execution and report	EIA execution hiring document
9 December 2015	Board committee decided to execute the project	Minute of Board meeting on December 9, 2015
9 December 2015	Approved company license	A memorandum of bilateral collaboration between FTP and the department of energy business
23 December 2015	Investing for a fuel depot in Phichit	Fuel depot construction document
26 February 2016	Hiring contracts of Project Management Consultant (PMC) and Construction Supervision Consultant(CSC) in Northern Fuel Pipeline Transportation Project (NFPT)	Contract of Project Management Consultant (PMC)_ Northern Fuel Pipeline Transportation Project (NFPT)
30 June 2016	A memorandum of EIA contract for Northern Fuel Pipeline Transportation Project (NFPT)	MD-IOC-163/2559 Inter-Office Communication

29 September 2016	Started pipeline procurement for project execution	Contract Documents for Coated line pipe for Northern Fuel Pipeline Transportation Project (NFPT)
27 June 2017	EIA approval of the Northern Fuel Pipeline Transportation Project (NFPT)	Letter from Office of Natural Resources and Environmental Policy and Planning (ONEP) to inform the EIA approval

The following CDM approved baseline and monitoring methodology is applied to this project:

AM0110 Modal shift in transportation of liquid fuels, version 02.0

For more information regarding the proposed new methodology and the tools as well as their consideration by the CDM Executive Board (hereinafter referred to as the Board) please refer to <http://cdm.unfccc.int/methodologies/PAmethodologies/index.html>.

1.2 Sectoral Scope and Project Type

Sectoral scope 7: Transport is applicable to the project of "Northern Fuel Pipeline Transportation Project, Thailand".

1.3 Project Eligibility

The project is under the scope of VCS program as follows:

- The project aims to reduce GHG emissions that include in the Kyoto Protocol Greenhouse Gases
- Project activities supported by a methodology approved by the UNFCCC's Clean Development Mechanism (CDM) which are eligible for use with the VCS Program

1.4 Project Design

The project was designed to include a single installation of an activity.

Eligibility Criteria

The proposed project is a single project and not a part of the grouped project, so it is no need to provide additional information relevant to the design of the grouped project.

1.5 Project Proponent

Organization name	Fuel Pipeline Transportation Limited (FPT)
Contact person	Mr.Charoen Charusalaipong
Title	Managing Director
Address	424 Kamphaeng Phet 6 Rd., Don Mueang, Bangkok, 10210 Thailand
Telephone	+662 574 6180, +662 929 5555
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Organization name	Bangkok Aviation Fuel Services Public Company Limited (BAFS)
Contact person	Mr.Prakobkiat Ninnad
Title	Managing Director
Address	171/2 Kamphang Phet 6 Rd., Don Mueang, Don Mueang, Bangkok, 10210 Thailand
Telephone	+662 834 8900
Email	prakobkiat.n@bafs.co.th

1.6 Other Entities Involved in the Project

Organization name	ERM-Siam
Role in the project	ERM is responsible for preparing the Project Description (PD) and the Monitoring Report to the Validation/Verification body according to VCS guidelines and procedures.
Contact person	Dr.Chacharee Therapong
Title	Principal Consultant
Address	179 Bangkok City Tower 24th Floor, South Sathorn Road, Tungmahamak, Sathorn, Bangkok, 10120 Thailand
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1.7 Ownership

FPT is the entity responsible for the execution and supervision of "Northern Fuel Pipeline Transportation Project, Thailand"

1.8 Project Start Date

The project start date for the purposed project is 01/05/2019, which signifies the beginning of the commercial operations.

1.9 Project Crediting Period

The project proponent will apply a10 year crediting period from 01/05/2019 to 30/04/2029. The crediting period will not be renewable.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	
Large project	X

Year	Estimated GHG emission reductions or removals (tCO_2e)
2019 (01/05/2019-31/12/2019)	18,779
2020	27,977
2021	27,977
2022	27,977
2023	27,977
2024	27,977
2025	27,977
2026	27,977
2027	27,977
2028	27,977

2029 (01/01/2029-30/04/2029)	9,198
Total estimated ERs	279,767
Total number of crediting years	10
Average annual ERs	27,977

1.11 Description of the Project Activity

The Fuel Pipeline Transportation Limited (FPT) is the first company in the country to initiate a liquid fuel pipeline project to the northern part of Thailand. This Modal Shift in Transportation of Liquid Fuels Project is an extension of the existing pipeline aiming to reduce Greenhouse Gas (GHG) emissions from land transportation of liquid fuel, by opting for a pipeline system in the Northern part of Thailand instead. The project has planned to construct the pipeline from Bang-Pa-In depot to i) Kamphaeng Phet station, and afterwards Phichit Depot, ii) Lampang Depot. The expected project lifetime is at 30 years; with the estimated maximum capacity of the pipeline at 9,000 million liters per year.

The FPT's fuel pipeline transportation system has routes that align to a network system on the rural road and highway route. Its fuel piping system routes start from Bang Pa In Depot, with 14-inch diameter, within the areas of the left side of highway route no. 347, towards an intersection with highway route no.32; then continuing toward highway route no.1, which is the route to Kamphaeng Phet station. From this point, the fuel piping system is located in an area on the right of highway no.32, no.122 and no.1, towards to a high-pressure pump station in Kamphaeng Phet province.

From 4 stations in Kamphaeng Phet, then the pipeline (12 inch in diameter) is located in an area to the right of highways no. 112 and no.115 towards the fuel depot destination in Ban Na sub district, Wachira Barami district, Phichit province. Then, its continued route is located in the area of highway no.1 towards destination of Fuel Depot in Sob Prab sub district, Sob Prab district, Lampang province. The overall distance from Bang Pa In depot in Ayuthaya to Phichit Proivince is 367 km., while the distance from Kamphaeng Phet province to Lampang province is 209 km; this consequently means the total length of all routes' pipeline is 576 kilometers.

As mentioned, the fuel pipeline system is a multi-products pipeline which can deliver various types of fuel in a pipeline. Four fuel types of products will be delivered: Gasohol 95, Gasohol 91, Diesel and Jet A-1 aviation fuel. All products have to be qualified and quality assessed. For example, Gasohol 95, Gasohol 91 and Diesel meet to be qualified according to Department of Energy's Business Standards and Jet A-1 aviation fuel has to be qualified following to Aviation Fuel Quality Requirements for Jointly Operated Systems (AFQRJOS) which aligns to British Ministry of Defense Standard and ASTM Standard Specification D 1655-15.

Presently, the FPT's fuel pipeline transportation system is able to deliver multi products of liquid fuels in one pipeline. Liquid fuel from the fuel hub in Bang-Pa-In district, Ayuthaya province will be pumped by high pressure pumps and transported through ground fuel piping system of 14- and 12-inch diameter to Lampang province.

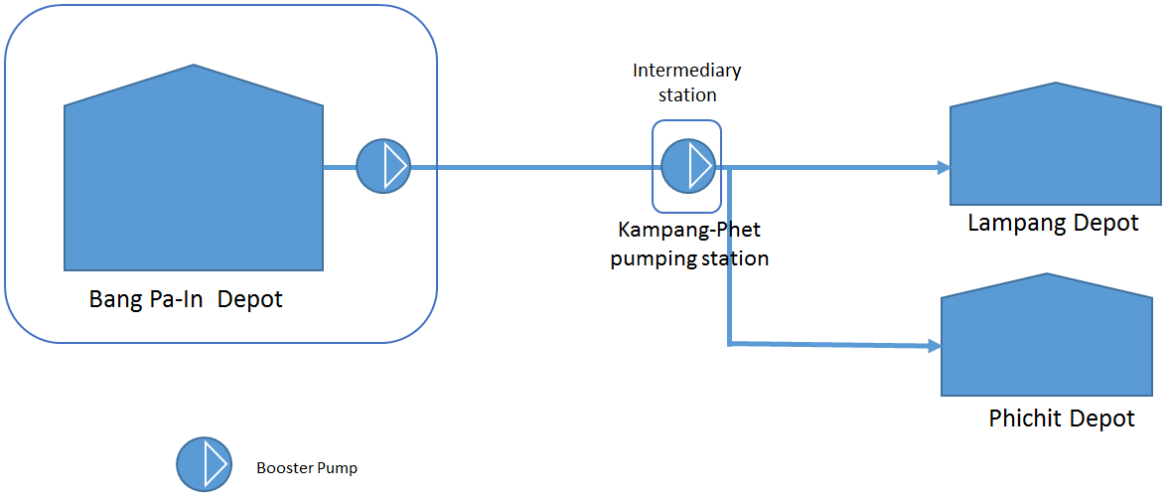


Figure: Schematic of project

The project activity consists of approximately 576 km of pipeline installed along the rural roads and highways, 2 high pressure pump stations and two liquid fuel depots. The list of facilities, systems and equipment in operation are in the table below.

Table: List of facilities, systems and equipment in operation

Name	Specification	Quantity
Pipeline (Bang Pa-In to Kampaeng Phet)	• **Size:** 14-inch • **Thickness:** 7.840mm (0.294 inch) wall thickness • **Design pressure**: 100.2 barg@50°	292 km
Pipeline (Kampaeng Phet to Pichit and Kampaeng Phet to Lampang)	• **Size:** 12-inch • **Thickness** 8.294mm (0.327 inch) wall thickness • **Design pressure:** 125 barg@50°	284 km
Pre-booster pump (Bang Pa-In)	• **Manufacturer:** Sulzer Pump UK LTD • **Model No.:** OHH 8X10X21A-1	1

	• **Type:** Centrifuge pump • **Capacity:** 320-360 m3/hr • **Power:** 75 kW	
BPI Offtake Pump (Bang Pa-In)	• **Manufacturer:** Sulzer Pumps UK LTD • **Model No.:** MSD 6X8X12.5B/9S • **Type:** Centrifuge pump • **Capacity:** 320-360 m3/hr • **Power:** 1,250 kW	1
IPS Pump (Kampaeng Phet)	• **Manufacturer:** Sulzer Pumps UK LTD • **Model No.:** MSD 6X8X15.5B/7S • **Type:** Centrifuge pump • **Capacity:** 320-600 m3/hr • **Power:** 1,800 kW	1
Turbine flow meter	<u>At Bang Pa-In station</u> • **Manufacturer:** Emerson/Daniel • **Model:** 1500 Series • **Calibrated range:** 135-600 m^3/hr • **Meter rated capacity:** 135-1,250 m^3/hr • **Linearity:** +/-0.15% over the normal flow range • **Repeatability:** +/-0.02% over the normal flow range <u>At Kampaeng Phet station</u> • **Manufacturer:** Emerson/Daniel • **Model:** 1500 Series • **Calibrated range:** 135-600 m^3/hr • **Meter rated capacity:** 135-1351 m^3/hr • **Linearity:** +/-0.15% over the normal flow range • **Repeatability:** +/-0.02% over the normal flow range	1 1
Electrical Power meter	• **Model:** Elite 440 • **Measurement voltage range:** 57.7-300 V AC (L-N) • **Approval standard:** IEC61010-1, IS14697, IE62053	1

1.12 Project Location

The project location and geographic coordinates are shown below.

Route	Geographic Coordinates
From	
Bang-Pa-In terminal, Bang Krasan sub-district, Bang-Pa-In District, Phra Nakhon Si Ayutthaya province	14°10'20.18" N 100°32'44.51" E
To	16°24'2.31" N 99°31'9.47" E
Kamphaeng Phet station, Ang Thong sub-district, Mueang district, Kamphaeng Phet province	
From	
Kamphaeng Phet station, Ang Thong sub-district, Mueang district, Kamphaeng Phet province	16°24'2.31" N 99°31'9.47" E
To	
Phichit depot, Ban Na sub-district, Wachira Barami district, Phichit province	16°30'43.08" N 100° 7'56.55" E
From	
Kamphaeng Phet station, Ang Thong sub-district, Mueang district, Kamphaeng Phet province	16°24'2.31" N 99°31'9.47" E
To	
Lampang depot, Sob Prab sub-district, Sob Prab district, Lampang province	17°54'28.80" N 99°20'22.84" E

Figure: the location of the project activity in Thailand

1.13 Conditions Prior to Project Initiation

The pipeline installation is designed to be located in parallel with the highways and rural roads, passing through 10 provinces. The approximate distances are 576 km (from Bang Pa-In depot to Lampang depot). At Lampang pipeline outlet station, environmental impact assessment has been conducted in 3 km radius area. The geographic coordinates of pipeline inlet station (PIS) and pipeline outlet stations (POS) are 14°10'20.18" N 100°32'44.51" E, 16°30'43.08" N 100° 7'56.55" E and 17°54'28.80" N 99°20'22.84" E].

Prior to the project implementation, land transportation has been the key mode in keeping liquid fuel supply in Northern Thailand running. Pipeline transportation will reduce the amount to 50 million kilometers per year. This means significantly less Greenhouse Gas emissions from the delivery trucks, which are the main source of emissions in the baseline scenario is the trucks' diesel consumption. They are on complementary routes to fill up the liquid fuel at depots. For Identification and justification of baseline scenario refers to section 3.4.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

Northern Fuel Pipeline Transportation Project will adhere to all the legal requirements that are currently in force in Thailand, together with all the sectoral permits for its execution, especially compliance of Department of Energy Business regulations and regulations of office of the Prime Minister on Public Hearing B.E. (2005).

The Northern Fuel Pipeline Transportation Project also supports the Energy Efficiency Plan; EEP (2015) to improve efficiency of fuel transportation cost and mitigate environmental impact, since the fuel pipeline transportation is a closed system, which has no impact on environment compared to fuel transportation trucks that emit toxic vapors to atmosphere. Moreover, Department of Energy Business, Ministry of Energy, approved The Northern Fuel Pipeline Transportation Project on September 4th, 2015.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The purposed project has not been registered, or is not seeking registration under any other GHG programs.

1.15.2 Projects Rejected by Other GHG Programs

The project has not been rejected by any other GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

No project reduce GHG emissions from the purposed activity are included in emissions trading program or any other mechanism that includes GHG allowance trading.

1.16.2 Other Forms of Environmental Credit

This purposed project has not received another form of GHG-related environmental credit.

1.17 Additional Information Relevant to the Project

Leakage Management

The purposed project is not applicable.

Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description.

Sustainable Development

The project contributes to Thailand's 20-Year National Strategy and Thailand 4.0 Policy as follows:

Improve life quality and environmental friendly: The project reduces amount of on-road fuel transport and traffic congestion of Thailand. The implementation of the project can directly reduce on-road transport GHG emissions in a more environmental friendly approach.

Urban and infrastructure development: The project accelerates urban and infrastructure development in the northern-part of Thailand by increasing capability of fuel transport to meet oil future demand in the future. The project is one of the initiatives in Thailand in integrating technology to replace conventional approach of transport and move toward the development of smart industry and smart city.

Further Information

The purposed project will not receive any public funding from parties included as an annex 1 country under the Kyoto Protocol.

2 SAFEGUARDS

2.1 No Net Harm

The potential negative environmental and socio-economic impacts and mitigation actions are taken to be in accordance with environmental impact assessment (EIA) which are summarized in the section 2.3

2.2 Local Stakeholder Consultation

The time between processes of planning and construction of Northern Fuel Pipeline Transportation Project, numerous social engagement activities were engaged with Communities, Government Agencies NGOs, Medias and Involved Organizations.

There were at least two social engagement activities that executed during the process which are

1) ***The first social engagement activity*** was aimed to present project information and impacts in positive and negative aspects and receive stakeholders' comments, considerations and recommendations as input materials related to project's environmental impact assessment guideline.
2) ***The second social engagement activity*** was purposed to present the project's environmental impact assessment results and the draft of environmental impact prevention and mitigation measures to involved stakeholder groups. This second social engagement activity was opened to get stakeholders' feedbacks and comments' inputs for improving the draft of environmental impact prevention and mitigation measures.

Moreover, Northern Fuel Pipeline Transportation Project was implemented stakeholder engagement procedure following to regulations of office of the Prime Minister on Public Hearing B.E. (2005).

The social engagement activities cover all areas of Northern Fuel Pipeline Transportation Project from Bang Pa In in the Central part to Lampang province in the North part of Thailand in main focus areas where have direct and indirect impacts. All main focus areas are scoped by the distances of 500 meters in radius from mid-point of fuel pipeline and of 3 kilometers in radius from fuel depot in 10 provinces which are i) Phra Nakhon Si Ayutthaya, ii) Ang Tong, iii) Singburi, iv) Lopburi, v) Chai Nat, vi) Nakhon Sawan, vii) Phichit, viii) Kamphaeng Phet, ix) Tak and x) Lampang provinces.

Northern Fuel Pipeline Transportation Project uses the processes of stakeholder analysis to identify all major groups of stakeholders in their roles, authorities and impacts to project development. The stakeholder analysis results support stakeholder participation levels and decision making processes, including the future impact assessment of project, negative impact mitigation and making good relationships between project owner and groups of stakeholders. Communications were made to respective governmental agencies and local authority to

communicate about the project, to gather feedback and recommendations, as well as arranging for public hearing in each area. The meetings were organized from 28th October 2015 to 12 November 2015, covering 10 provinces mentioned above. A total of 26 public participations have been organized, with 3,323 participants. Conclusion of all sessions, including criticisms, suggestions, preventive and mitigation measures for the project were posted to the governmental agencies and community leaders for further distribution.

Social engagement and public participation issues cover three dimensions of environment, social and health and safety on major focus areas in 10 provinces. The summary is in the table below:

Table: Conclusion of Social engagement and public hearing issues for scope design and EIA Guideline

Province Area	Question issues/ Concerns/ Recommendations		
	Environmental Dimension	Social Dimension	Health and Safety Dimension
Chai Nat	-Air pollution, noise and vibration during construction	-Project's measures in managing construction workers' accommodation. -Communication between the project and the locals need to be thorough.	- Mitigation of risks from pipeline explosion and spillage
Ang Tong	-Dust and noise pollution from machines during construction	-Communication with communities -Project's measures in managing construction workers. -Communications to relevant agencies prior to construction are needed to avoid traffic problem	-Health and safety assessment approach in EIA report
Singburi	-Waste management method	-Effectively cooperating and collaborating among construction contractors, Local Agencies and Local headmen during construction -The roads' capability in upholding the pipeline -Construction worker concerns	-Identification of construction accident prevention plan -Frequency of pipeline's strength inspection

Province Area	Question issues/ Concerns/ Recommendations		
	Environmental Dimension	Social Dimension	Health and Safety Dimension
Nakhon Sawan	-Noise and vibration could affect to nearby accommodations during construction	-Prioritization for local employment -Relocation of a fuel depot to Kampaeng Phet area	-Community's safety in pipeline areas
Ayutthaya	-Soil erosion on land and change in stream direction impacts to local residences, farmers and vendors nearby construction area -Air pollution during construction stage	-Collaborating among contractors, Local Agencies and Local headmen during construction -Establish project's public grievance committee and channels for suggestion/complaint. -Reduction of accidents from liquid fuel delivery trucks after the project implementation	-Disposal waste impacts to local residences and agencies during construction
Kampheang Phet	-Water resources management plan -Soil erosion on land -Pipeline area and its probability of being flooded	-Installation of construction warning sign every 500 meters in day and night time -Local employment in patrol line -Committee to inspect the project's progress, with the public participation	-
Phichit	-Water resources management plan	-Corporate social responsibility activity execution before project's operation - Road traffic during construction stage	-Explosion risk from pipeline and fuel depot
Lopburi	-Mitigation measure for noise and dust impact	-Established project's public grievance center	-
Tak	-Vibration during construction phase -Waste management measures in consideration of the incoming flow of construction workers in the area	-Promotion of local activities such as sport or scholarship -Clear construction schedule -Local construction employees	-Accident during construction phase and community's safety -Prevention measures against noise pollution and any health impacts

Province Area	Question issues/ Concerns/ Recommendations		
	Environmental Dimension	Social Dimension	Health and Safety Dimension
			that may incurred from the project
Lampang	-Identification of life time of pipeline -Local community can monitoring project's waste management -In case of leakage, identify the mitigation and maintenance policy -Noise pollution could affect around community areas during construction phase.	-Crime and drug problem from migrant labours -The project must follow agreement with community -Public hearing before project implementation -Community representative to join in the project inspection after land restoration in each construction area	-Earthquake might affect oil depot -Health authorities are able to monitor the risk of the disease -Impacts to health and safety following a pipeline accident in any forms

2.3 Environmental Impact

The Office of Natural Resources and Environmental Policy and Planning (ONEP) 2012 pointed out that Thai regulation for the oil and gas industry must report their environmental impact assessment (EIA) and completes environmental impact report. In this project, the EIA has been approved on June 27th, 2017. This EIA report includes an assessment of the project's environmental issues and mitigation approach, which can be categorized into 10 main impacts as shown in the table below.

2.3.1 Transportation

The project preparing on the activities that occur during the construction period by following the rule and regulations of related departments. Thus, for the safety concerns, the employee involving in the project must be trained under the Health Safety& Environment Management Plan.

Detail	Mitigation
The project has prevent the impact that occurs during the construction period such as speed limit within the community area and also collaboration for the related agencies on planning traffic jam, train the contractors,	• Avoiding traffic jam during the construction period by collaboration between department of highways and related agencies. • Announcing the construction details one week ahead to relevant organizations such as local authorities, community leader and others.

installation of the relevant signs and preparing for any emergency.	• Placing concrete barrier and installing clear warning sign for the construction zone. • The contractor and driver must be trained strictly under the rule and regulation of the department of high way and safety instructions. • The speed will be limited for the construction area and community at 60 kms. per hr. and for other area at 80 kms. per hr. Installing the speed limit sign for the construction area and at the entrance of construction area. • The truck weight will be controlled by following the regulations of the Land Transport Department. • Conducting tool box talk every morning. The content is mainly on safety instructions. • Moving unnecessary scrap or obstruction from the transportation route and limit transport the pipelines in each area for one day working. • If the construction damage the public road, sign and traffic light, the project will responsible for repairing all the damage. • Announcing public construction plan with the detail of construction periods, 24 hours telephone number for any complaints and any emergency in front of the project office. • The truck must use the cover sheet for protecting the scrap materials that may fall out to the road. Conduct tool box talk every morning. The content is mainly on safety instructions. • Avoiding transport the construction materials on rush hours at 07.00-08.00 a.m. and 17.00-18.00 p.m.

2.3.2 Drainage and flooding

The impact to ability of drainage and flooding is very low due to the activities not impede water flow.

Detail	Mitigation
During the construction process, the activity may obstruct the water flow by the activity of excavating the soil for pipping. However, the prevention plan is preparing in case of any emergency and safety.	• During heavy raining, no construction allowed. • Tool box talk every morning for remind the contractor on safety instruction. • Preparing sufficient spare pump for water drainage during raining season. • Prohibit of throwing any garbage into the drainage pipe and tool box talk every morning for remind the contractor on safety instruction. • If the project need to shut down the water flow of main pipeline, it required temporary bypass channel for making the water flow. • Increase the frequency of monitoring plan to inspect drainage pipeline. • Sediment pond and rainspout are required within the construction area for slowing down the water and catcher some of sediment before going down to the water trough. • After construction finishes, the project needs to rebuild the natural water way to be normal

2.3.3 Soil resources and surface soil erosion

The activities during the construction process such as preparing the land, furrow and landfills will impact to the surface soil erosion.

Detail	Mitigation
The prevention plan of soil erosion has being implemented during the construction period. The plan	• Excavation needs to separate the surface soil and the subsoil. When finished the construction, they need to backfill with the subsoil following by the surface soil for remain organic matter to the right position of soil.

is emphasized to two sensitive areas of soil erosion as follows. 1) Tak province at moderate intensity level (low land:3) 2) Lam prang at intense level (high land: 4H).	• If the project has obstructed public road, they need to move all debris out of the area and adjust the land to be normal. • To do excavation, the project must install sheet pile or trench box in order to prevent the soil erosion and worker safety. • The activities that involve with the soil must not operate during the heavy rain and tool box talk every morning for remind the contractor on safety instruction. • When construct the transfer pond close to the natural water sources, the project needs to build at least 60 centimeter ridge around the area in order to prevent the soil erosion from the water sources. • The project needs to collect the soil data and ground water level along the fuel pipeline at the control center before operating. • Demolish all the buildings after finished construction for preventing the impact to the soil resources.

2.3.4 Land Ecology

The pipeline route is lied on along the road which is belong to the area of Department of High Way and Department of Rural Roads. For some area close to conserved forest, the project must strictly follow the regulation of Department of Forest and related agencies.

Detail	Mitigation
During the piping, the impact to conserved forest was found on the construction period. However, when operate the fuel pipeline, the activity that below 1.5 meter of underground can fully use	• To investigate the number and type of the trees in order to move or replace in each area under the requirement of the Department of Highway. • During the preparation of the construction, if the project found the trees which the average of the high equal to the chest approximately 30 centimeter, they must be move out the trees and plant to nearby area.

utilize without impact to the land ecology.	• If the project need to cut down the trees or move out, it should follow the regulation of the Department of Highway. • The project required to have rule and regulation of hunting prohibit for employees and workers. Thus, the penalty needs to be strictly for offender. • Do not provide the shelter or worker camp around the forest area in order to reduce the impact of natural resources and wildlife during the construction period. • Avoiding impact to ecology during the construction. In case of cannot restore ecology, the project needs to compensate.

2.3.5 Land use

The area of piping the fuel pipeline mostly lied on the areas of Department of High way and Department of Rural Roads that consists with local community, wasteland and agricultural.

Detail	Mitigation
During the construction process, the impact to the land mostly are wasteland and agricultural areas. However, the impact to the community only for the short period at beginning of the project at drilling area.	• Before starting the project, the energy network system within the construction area needs to be consult with the landlord and the Department of High way before the construction. • After piping, the project have to backfill along the fuel pipeline to be in the same condition. • Before the construction at agricultural area, the project needs to inform the agriculturist for harvesting the goods in order to reduce the impact on the agricultural sector.

2.3.6 Occupation health and safety

In order to prevent any accident for the worker and local people along the fuel pipeline, Health Safety& Environment Management Plan is being used for reduce the accident during the construction period.

Detail	Mitigation
The impact on health and safety on both construction period and operating period are the workers and employees who perform the job along the pipeline areas. The safety instructions, personal protection equipment emergency plan are provided and prepared for the worker's safety.	• Contractor must write the proposal on occupation health, safety and environment together with emergency plan. Then, it needs approval from the project owner before being use as a defensive measure. • Contractor should strictly follow the regulation on the safety plan during the construction period and tool box talk every morning for remind the contractor on safety instruction. • The protective equipment needs to be suitable for each jobs and persons. Additionally, the safety training must be trained to the contractors and employees for the safety equipment instruction. • In case of working at height, the project should provide rope and others life-saving equipment according to requirement of the law. • Safety officer has responsible for checking and controlling all the safety equipment for individual employees. • Checking public utility along the fuel pipeline and marking the symbol for the worker to be aware of the accident. • Before connecting the fuel pipeline, the contractor should do Tie-in procedure, safety procedure and emergency response procedure. Then, it needs approval for the project owners that responsible for the pipeline for using the welding equipment. • During drilling, the workers are not allowed to going down to any pond or nearby area in term of the safety. • Collaboration with local police station and Disaster Prevention Department for the safety and emergency respond.

	• Immediately report the accident to supervisor when found the injury or emergency and report the accident's details by written. • The project owner must control the contractor to follow the environment regulation. If the project found any impact to the environment, they need to resolve immediately.

2.3.7 Hazardous Action Plan

The project evaluated the worst cases of operating the fuel pipeline such as oil spills from the pipeline and the explosion of the fuel storage tank so the high standard of safety, design and professional contractor are carefully considered in order to reduce the impact at the critical level.

Detail	Mitigation
The activity which sensitive impact to the project is piping the pipeline cross with others factory's pipeline during the construction. Thus, the safety standard and emergency plan highly considering in each step of starting construction for prevent any critical event.	• Before the construction, the contractor must prepare the occupation health and safety plan to the Fuel Pipeline Transportation Limited for the approval. • Identify the welding location to be a specific area and do not allowed any activity that cause of heat or spark by preparing the warning sign and required the work permit before entrance the area. • Place fire extinguisher in the right proportion for the construction area. • Respond to any emergency by preparing the first aid at the field work and stand by the transportation to the hospital.

2.3.8 Social and Economic

Operating the project will has positive impact by hiring local people and support the local economy. However, the negative impact only found for non-local worker.

Detail	Mitigation
During the construction, the impact will effect directly to the people who live nearby highway number 1 and 32 especially for 50 meters of	• Public hearing must be conducted to inform the construction plan, the impact to the community, the collaboration and the emergency plan during the operation for local's leader, local administration, police officer and surrounded communities.

radius of pipeline. The example of impacts such as noise, dust and vibration are concerned and prevented by providing public insurance system for any damage that cause to life or their assets.	• Announcing the construction plan one week ahead for local authorities before the construction. • Established the complaint center for collaboration and announce the project implementation to the local people. • Providing the public insurance system for any loss or damage that caused to life and assets. • Collaboration with the public and private sectors for solving the problem and maintain the relationship. • Considering to hire the local people first by their skills and job requirements. • Supporting any local activities such as traditional, education, sport and public benefit.

2.3.9 Public Relations

The project considering to announce the details during the construction and emergency plan to the local communities and nearby organizations for prevent an error communication.

Detail	Mitigation
Announcing the important information and maintaining the good relationship to the local communities and related parties are importantly for the long term plan.	• Public relation officer must frequently visit the local communities along the pipeline for information and building relationship. • Announcing the project information, safety and emergency plan for the local communities and schools for create understanding between the parties. • Supporting the public activities and sustainable development for the local communities along the fuel pipeline.

2.3.10 Public Health

The project has highly concerns on human health and emergency respond under the labor legislation and utility standard for public health.

Detail	Mitigation
For prevention from the accident or disease, the project will provide enough utility and aware of contagious disease for the worker and relevant persons.	• Providing first aid at the construction area by standby at least 1 ambulance and coordinate with the local hospital in case of emergency respond. • The contractor must follow the labor legislation for medical examination. • Provide health training course in case of any emergency for the workers and employees before starting the construction. • Be aware of contagious disease by coordinate with the local public health. • At the field work office, it should provide enough public utility according to the standard and relevant regulations. • Setting the condition of contractor for worker accommodation such as location, toilet sanitary and waste disposal to ensure that it will not effect to the environment and community. • Provide the budget for public health activities around the construction area including the knowledge of contagious disease.

2.3.11 Historical and Archelogy

The project construction will under the approval for Fine Art Department and related parties in the case of constructed closed to the historical area.

Detail	Mitigation
Before the construction, the project studied did the survey together with archeologist along the fuel pipeline in order to ensure that the	• Coordinate with Fine Art Department for construction around the historical area including approval for construction process to ensure that the project will not impact to the historical and archelogy area. • Preparing the plan and survey of historical along the fuel pipe line by get the permission from the director

construction will not impact to the historical area.	general of Fine Art Department and related organizations. • If piping the pipeline close to historical place and archelogy, the project required archeologist for observing and controlling during the operation. • Pausing the construction immediately when found any historical object and informed the relevant agencies for investigate. • After finish the construction along the fuel pipeline, the project needs to adjust the landscape to be the same condition.

2.4 Public Comments

As stakeholder comments are taken as a part of the environmental impact assessment report to the government agency, all of the concerns are addressed and their mitigation measures are provided in the EIA.

Figure: Regional government agencies and local municipalities' engagement

Figure: Public participation session with local communities

2.5 AFOLU-Specific Safeguards

The project is non-AFOLU project, this section is not required.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The following CDM approved baseline and monitoring methodologies are applied to this project:

AM0110 Modal shift in transportation of liquid fuels, version 02.0

For more information regarding the proposed new methodology and the tools as well as their consideration by the CDM Executive Board (hereinafter referred to as the Board) please refer to <http://cdm.unfccc.int/methodologies/PAmethodologies/index.html>.

3.2 Applicability of Methodology

The proposed project activity meets each of the applicability conditions of the methodology of AM0110 Modal shift in transportation of liquid fuels, version 02.0, as justified in Table below.

Table: Justifications of the applicable conditions in the selection of the methodology

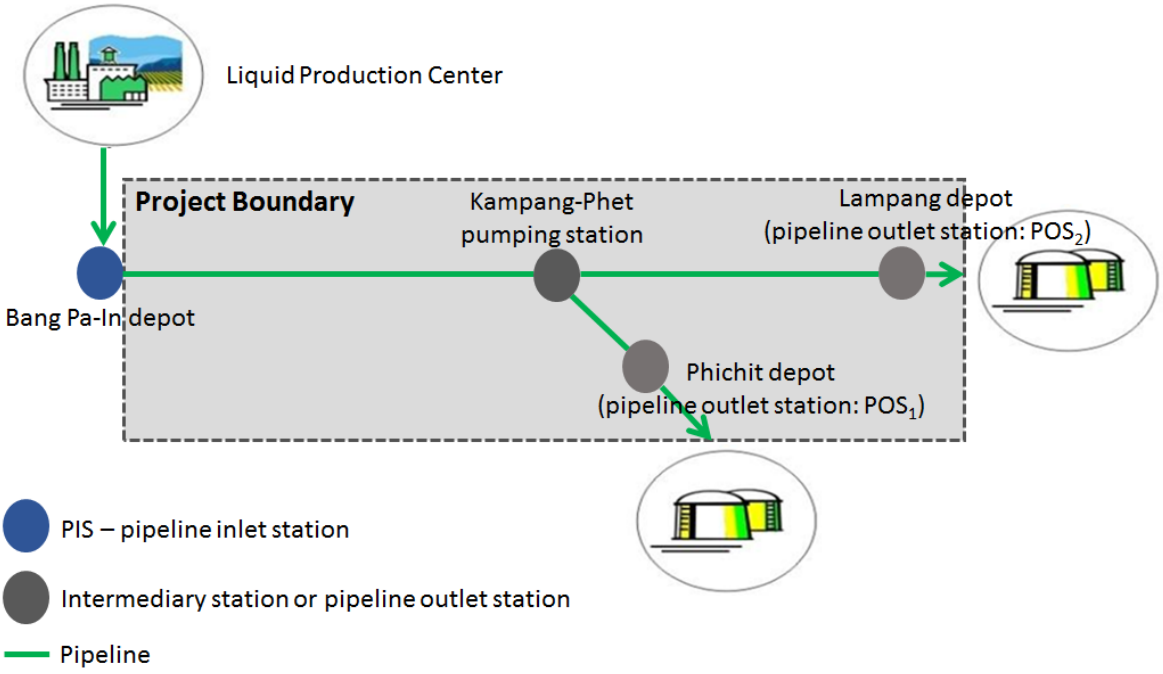
Applicability conditions	Justification
(a) The methodology is applicable for the transportation of liquid fuels only.	This project activity aims to shift the transportation mode of liquid fuels from land transportation to pipeline system

	which support the liquid fuels supply in northern part of Thailand. Hence, the methodology use is explicitly for transportation of liquid fuels.
(b)The pipeline network operator is the project participant. If the pipeline network operator is not the owner of the liquid fuels to be transported under the clean development mechanism (CDM) project activity, the owner(s) may also be included as project participants.	In this project, the pipeline network operator or FPT is the project owner. However, the owners of liquid fuels to be transported under this project are not included as the project participants.
(c)If the owner(s) of the liquid fuel is/are not project participants, a contractual agreement between the liquid fuel owner(s) and the project participants shall ensure that the liquid fuel owner(s) do not claim any certified emission reductions (CERs) from the transportation of the liquid fuel by pipeline.	The agreement between the pipeline network operator or FPT and the owners of the liquid fuel has been signed to ensure that the emission reduction credits from liquid fuel transportation in the pipeline go to the project owner.
(d)The liquid fuel is transported using two or multiple pre-identified nodes of pipeline network. The nodes and corresponding branches of the pipeline network are defined in the VCS project design document (VCS-PDD) at the validation of the project activity and remain fixed during the crediting period.	The original pipeline network has been placed to deliver the connecting node from Bangpa-In depot (considered as pipeline inlet station: PIS) to Phichit depot (pipeline outlet station: POS_1) and Lampang depot (pipeline outlet station: POS_2) are remain fixed during the crediting period as validated in the project design documents.
(e)The type of liquid fuel to be transported under the project activity is defined in the VCS-PDD at the validation of the project activity and no change of type of liquid fuel is allowed thereafter.	The transported liquid fuels types that have validated as the project activity are diesel, gasoline and jet A1. There will be no change afterward.
(f)The methodology is not applicable for operational improvements of an existing pipeline that is in operation.	The scope of the project is the newly installed pipeline. Thus, the methodology is not involving the operational improvements of the existing one.

(g)The geographic conditions of the project site permit the use of different transportation means (e.g. pipeline, trucks, etc.).	The pipeline will lie in line with the existing highways and rural roads. As a result, the geographic condition of the project allows transportation via trucks.
(h)There is sufficient road transportation capacity to transport the liquid fuel from the point of origin (o_j) to point of destination (d_j) by trucks at the time of implementing the VCS project activity and for the duration of the crediting period.	At the time of project implementation, the capacity of road transportation from the Bang Pa-In depot to Phichit depot and to Lampang depot is sufficient to support the transportation of the liquid fuel. The total distance of the pipeline is approximately 576 km.
(i)If blended biofuel is used, the conservative approach shall be applied in adopting a zero emission factor for biofuels in the baseline scenario and in the project activity it shall be considered as the same emission factor of the fossil fuel being used.	The blended biofuel has not been used in baseline scenario and in the project activity.

3.3 Project Boundary

The project boundary is depicted below.



The project boundary includes emission sources as detailed below.

Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from road transportation of liquid fuels from point of origin to point of destination	CO_2	Yes	Significant emission source
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
Project	Emissions from road transportation of liquid fuel in complementary routes	CO_2	Yes	Significant emission source if electricity is produced from fossil fuels
		CH_4	No	Excluded for simplification. CH4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. CH4 emissions are assumed to be very small
	Emissions from on-site use of electricity and/or fossil fuels to operate the pipeline system	CO_2	Yes	Significant emission source
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
	Emissions from land use changes associated with land clearance	CO_2	No	Excluded for simplification. CO_2 emissions are assumed to be very small
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small

3.4 Baseline Scenario

The selection of the baseline scenario and the demonstration of additionality shall be conducted using the latest version of the "Combined tool to identify the baseline scenario and demonstrate additionality". Section 3.5 of this document is following additional guidance that is applied the tool. The baseline scenario is the continuation of the current mode of transportation, which is "road transportation using trucks". This is the practice in status quote for transportation of liquid fuel to the northern part of Thailand. While this method has good coverage in areas accessible by trucks, it can be ineffective for long distance transportation. Using trucks also mean a reliance on depots, often situated in populated areas. This form of land transportation requires more energy in operation, resulting in great transportation cost and greenhouse gas emission. While there are no investment and technological barriers, this

alternative is eliminated on the basis of considerations to the environment and natural resources.

3.5 Additionality

According to AM0110, additionality shall be demonstrated for the proposed project by applying the Methodological tool of "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 06.0) *https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v6.0.pdf* , which the following steps were applied:

Step 0: Demonstration whether the proposed project activity is the first-of-its-kind

This proposed project is not the first-of-its-kind, so this step is not applied.

Step 1: Define alternative scenarios to the proposed VCS project activity that is consistent with current laws and regulations.

The following scenarios were identified as the realistic and credible alternatives to the project activity.

Alternatives	Justification/Explanation
M1: Road transportation using trucks	This alternative is the current land transportation for the liquid fuel to the northern of Thailand via trucks. No additional cost is provided.
M7: VCS project activity without being considered as VCS (e.g. pipeline network).	This alternative is not applicable because it will require additional capital expenditure of processing and transporting facilities. M7 is not sufficiently economically attractive.

The alternatives are in compliance with all mandatory applicable legal and regulatory requirements, even laws and regulations. No national laws or other regulations (e.g. environmental regulations) which implicitly restrict BAFS from the options.

Realistic and credible alternative scenarios that are in compliance with all mandatory enforced regulations are M1: Road transportation using trucks and M7: VCS project activity without being considered as VCS (e.g. pipeline network).

Step 2: Barrier analysis

Step 2a: Identify barriers that would prevent the implementation of the alternative scenarios

Alternative	Barrier Identification
M1: Road transportation using trucks	This is existing circumstance, so it has no barrier for this alternative. This alternative is the existing land transportation for the liquid fuel to the northern of Thailand via trucks. No additional cost is provided.
M7: VCS project activity without being considered as VCS (e.g. pipeline network).	The main barrier to prevent this alternative from the implementation is investment cost because it is required additional capital expenditure of processing and transporting facilities. M7 is not sufficiently economically attractive as further analysed in Step 3.

Step 2b: Eliminate alternative scenarios which are presented by the identified barriers

Only alternative (M1: Road transportation using trucks) is the plausible alternative scenario to the project activity because of no additional cost, so this alternative scenario is identified as the baseline scenario. In comparison to truck operating cost, this found to be approx. 6,030.81 million THB/30 years operation as compared to pipeline (80,621.92 million THB/30 years operation). This is significantly higher than baseline (truck) because there is no capital investment on truck since it is not the property of project owner. In addition, this is 13 times more extravagant than truck which cannot cover its additional benefits and is not considered financial attractive. Mode M2: Rail transportation is considered not applicable. Railways in Thailand are not suitable for transportation of liquid fuel as it takes long time to travel and has limited capacity. In addition, the limitation of rail tracks (limited routes) causes the low reliability on the part of rail freight transport in comparison with other transport modes. Its priority has been given to passengers rather than goods. Mode M3: Water transportation using barges are also not applicable because there are no major river connecting northern Thailand to Phra Nakhon Si Ayutthaya. Wang river and Ping River are susceptible to drought which make water a nonviable mode of transport. Transporting to Lampang using river is also geographically limited due to its small in size (width and depth). These two rivers are rather utilized for irrigation, agriculture, fishery, consumption and tourism. The M7: the propose project activity without being considered as VCS (e.g. pipeline network) has the main barrier to prevent its implementation because it is required high investment cost and it is not sufficiently economically attractive. However, this M7: proposed project activity with being considered as VCS (e.g. pipeline network) will alleviate the investment barrier that prevents the proposed project activity from occurring in the absence of the VCS.

Step 3: Investment analysis

Following the instruction of "Combined tool to identify the baseline scenario and demonstrate additionality", the investment analysis is conducted to demonstrate the proposed project activity is not financially attractive. Benchmark analysis is selected.

Benchmark analysis

The project IRR is selected as the financial indicator to be applied for the benchmark analysis for the proposed project activity. The financial indicator applied in the project activity as a benchmark is a weighted average cost of capital (WACC), which is 7.38%. Internal rate of return (IRR) is considered as the financial indicator to determine the viability of the Project. The outcome of IRR (3.925%) from the project activity is compared with the benchmark of 7.38%. As the result, the project IRR is significantly less than the benchmark, the project activity cannot be considered as financially attractive.

Calculation and comparison of financial indicators

The basic parameters and data used for the IRR calculation are shown in Table.

Table: Data Used for Estimation of the Project IRR

Parameter	Value	Unit	Source
Project lifetime	30	Year	Project activity
Total Investment cost	9,385.00	MTHB	Feasibility Study Report on 29 August 2015, Page 33, 35
Total O&M cost	21,726.91	MTHB	Feasibility Study Report on 29 August 2015, Page 35
Total Revenue	45,385.37	MTHB	Feasibility Study Report on 29 August 2015, Page 35
Exchange rate[(a)]	36.00	THB/USD	Bank of Thailand, as of 26 August 2015 http://www.bot.or.th

Parameter	Value	Unit	Source
Carbon price[b]	20	USD/tCO_2	Feasibility Study Report on 29 August 2015, Page 35 2015 National Carbon Dioxide Price Forecast, updated March 3, 2015 Figure ES-1, Page 4

Note: [a] Data as of 1 December 2015

[b] Average carbon price forecast, synapse energy economics, inc.

Table: Summary of the IRR

Detail	IRR
Project IRR (without VCS)	3.925
Project IRR (with VCS)	4.045
Benchmark	7.38

The results from data above showed that in case of no VCS, the Project IRR is 3.925%, which is lower than 7.38 % of the benchmark. So, it may be concluded that the financial of Project is unattractive. In the contrary, with the presence of carbon credit revenues, the Project IRR will help to increase to 4.045 %. This increase would allow the project activity to reduce the financial barriers, enabling its implementation.

Sensitivity analysis

A sensitivity analysis is carried to show whether the conclusion regarding the financial/economic attractiveness is robust to reasonable variations in the critical assumptions. For this analysis, variations covering a range of +10 and -10 % have been considered for the following parameters:

- Total project investment costs
- Total operating and maintenance (O&M) costs
- Total revenue

The sensitivity analysis of the project activity is calculated by varying the above parameters. The variation in the critical assumptions as compared to the base case and its IRR are presented in Table below.

Table: Results of the Sensitivity Analysis

Parameter	Variation	Project IRR
Without VCS		
Base case	-	3.925%
Total revenue	-10%	2.35%
	+10%	5.28%
Total project investment costs	-10%	4.54%
	+10%	3.38%
Total O&M cost	-10%	4.65%
	+10%	3.16%
With VCS		
Base case	-	4.045%

The results from the sensitivity analysis indicated that the optimistic case of the IRRs are not raised up to reach the benchmark (7.38%). However, after the revenue from carbon credit sale of 10 years crediting period is taken into account in the economic model, the IRR of the project activity with VERs revenue will increase up to 4.045%. This also confirmed that VCS incentive from the sale of VERs will assist the project activity to reduce investment barrier and determination to implement and this project activity is only possible under the registration as a VCS Project.

Step 4: Common practice analysis

Step 4a: The proposed VCS project activity(s) applies measure(s) that are listed in the definitions section above

According to the "Guidelines on Common Practice" (version 03.1), this part should analysis in the following:

Step 1: Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.

The applicable output range as+/-50% of pipeline distance at 576 km of the proposed project activity is from 288 to 864 km.

Step 2: In the applicable geographical area, identify similar projects (both VCS and non-VCS) that deliver the same output or capacity, within the applicable output range calculated in Step 1, as the proposed project activity and have started commercial operation before the start date of the project. Note their number N_{all};

There is no any similar project in the country to the one proposed in this project activity that constructs pipeline network and transportation of liquid fuel.

Therefore $N_{all}=0$

Step 4b: The proposed VCS project activity(s) does not apply any of the measures that are listed in the definitions section above

According to the "Guidelines on Common Practice" (version 03.1), the next steps are applied.

Step 3: Within projects identified in Step 2, identify those that are neither registered VCS project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number N_{all}.

As mentioned above, there is no similar project to the proposed project, therefore $N_{all}=0$.

Step 4: Within similar projects identified step 3, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number N_{diff},

As mentioned above, there is no similar project to the proposed project, therefore $N_{diff}=0$.

Step 5: Calculate factor F=1-Ndiff/Nall representing the share of similar projects using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

Due to no similar project activity in the country to the one proposed in this project activity that constructs pipeline network and transportation of liquid fuel.

The proposed project activity is a "common practice" within a sector in the applicable geographical area if the factor F is greater than 0.2 and N_{all}- N_{diff} is greater than 3. As analysis above, N_{all} - N_{diff}= 0 which is smaller than 3, and therefore, the project is not a common practice. It can be concluded that the common practice analysis confirms the conclusion of the previous sections. Without VCS support, the proposed project is not a viable alternative.

Based on the analysis presented in this section, the proposed project activity is deemed additional. It can be concluded that the proposed project cannot be implemented without VCS incentives.

3.6 Methodology Deviations

There is no methodology deviation.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The procedure for quantification of baseline emissions in accordance with the applied methodology is explained below.

$$BE_y = \sum (Tj,y \times AD_j, \times EF_{BL,i}, \times 10^{-6}$$

Where:

BE_y = Baseline emissions in year y (t CO_2)

$T_{j,y}$ = Amount of liquid fuel transported by the pipeline in route j in year y (ton)

AD_j = Distance of the baseline route j (km) which consider as the one way distance between the point of origin (O_j) and point of destination (d_j)

Note: The historical records are not available or if more than one route was used prior to the implementation of the project activity, then the project participants shall provide, with justification, a route between origin and destination which leads to the least fuel consumption. In this case, the direct route of the project activity is defined.

$EF_{BL,j}$ = Baseline emission factor for transportation of liquid fuel in route j (g CO_2 per ton.km that is g CO_2 per ton of liquid fuel and km travelled). The default emission factor is 76 g CO_2/ton.km if trucks consume petrodiesel.

BE_y	$\sum(T_{j,y} * AD_j)$	$EF_{BL,j}$
t CO_2	*ton.km*	*gCO_2 per ton.km*
27,977	*368,113,994*	*76*

4.2 Project Emissions

The procedure for quantification of project emissions is in accordance with the applied methodology. Project emissions in this project activity include "electricity consumption from the grid" to operate the pipeline system in the project activity and "fossil fuel consumption" to operate the pipeline system in the project activity.

$$PE_y = PE_{EC,y} + PE_{FF,y}$$

Where:

PE_y = Project emissions in year *y* (t CO_2)

$PE_{EC,y}$ = Project emissions from electricity consumption to operate the pipeline system in the project activity in year *y* (t CO_2)

$PE_{FF,y}$ = Project emissions from fossil fuel consumption to operate the pipeline system in the project activity in year *y* (t CO_2)

Project electricity consumption from the grid is calculated as follows.

$$PE_{EC,y} = EC_{p,j} \times EF_{grid,\,y}$$

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption to operate the pipeline system in the project activity in year y (t CO2)

$EC_{p,j}$ = Quantity of electricity consumed by the project electricity consumption in year y (MWh)

$EF_{grid,\,y}$ = Emission factor for grid electricity system (t CO2 per MWh)

Project fossil fuel consumption is calculated as follows.

$$PE_{FF,y} = \sum FC_{i,j,y} \times COEF_{i,y}$$

Where:

$PE_{FF,y}$	=	Project emissions from fossil fuel consumption to operate the pipeline system in the project activity in year y (t CO2)
$FC_{i,j,y}$	=	Quantity of fuel type combusted in process j during the year y
$COEF_{i,y}$	=	CO_2 emission coefficient of fuel type in in year y Note: National default values or IPCC default values in Chapter 1 of Vol.2 (energy) of the 2006 IPCC Guidelines

As the project activity has not implemented during this PD development, it is not plausible to calculate ex-ante project emissions.

4.3 Leakage

No leakage emissions are considered in the project.

4.4 Net GHG Emission Reductions and Removals

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2019 (01/05/2019-31/12/2019)	18,779	0	NA	18,779
2020	27,977	0	NA	27,977
2021	27,977	0	NA	27,977
2022	27,977	0	NA	27,977
2023	27,977	0	NA	27,977
2024	27,977	0	NA	27,977
2025	27,977	0	NA	27,977
2026	27,977	0	NA	27,977
2027	27,977	0	NA	27,977
2028	27,977	0	NA	27,977

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2029 (01/01/2029-30/04/2029)	9,198	0	NA	9,198
Total	279,767	0	NA	279,767

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	$EF_{BL,j}$
Data unit	g CO_2 per ton.km
Description	Baseline emission factor for transportation of liquid fuel in route *j* (g CO_2 per ton.km, that is g CO_2 per ton of liquid fuel and km travelled)
Source of data	Default value according to AM0110 Modal shift in transportation of liquid fuels
Value applied:	76
Justification of choice of data or description of measurement methods and procedures applied	Default value according to AM0110 Modal shift in transportation of liquid fuels Condition: This default emission factor of 76 g CO_2/tonne.km if trucks consume petrodiesel or gasoline in the host country.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	EF_{grid}
Data unit	t CO_2 per MWh
Description	Emission factor for grid electricity system
Source of data	Default value from the study of emission factor for electricity generation of Thailand in year 2010, TGO
Value applied:	0.51
Justification of choice of data or description of measurement methods and procedures applied	This default value is the national *EFgrid* from the study of emission factor for electricity generation of Thailand in year 2010, TGO, which its calculation is complied with Methodological

	Tool (Version 02.2.1) "Tool to calculate the emission factor for an electricity system"
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	AD_j
Data unit	Km
Description	Distance of the baseline route *j* (km)
Source of data	from the project participants
Value applied:	

Route	Distance (km)
ADj_1	501
ADj_2	367

Justification of choice of data or description of measurement methods and procedures applied	According to AM0110 Modal shift in transportation of liquid fuels, if such historical records are not available or if more than one route was used prior to the implementation of the project activity, then the project participants shall provide, with justification, a route between origin and destination which leads to the least fuel consumption. In this project, AD_j is identified as the distance route of installed pipeline in the project activity.

Route	Detail
ADj_1	Route from Bang-Pa-In depot in Ayuthaya province, to Lampang depot in Lampang province
ADj_2	Route from Bang-Pa-In depot in Ayuthaya province, to Phichit depot in Phichit province

Purpose of Data	Calculation of baseline emissions
Comments	-

5.2 Data and Parameters Monitored

Data / Parameter	$COEF_{i,y}$
Data unit	t CO_2 per L
Description	CO_2 emission coefficient of diesel
Source of data	Calculation from default values of NCV and CO_2 emission factor for combustion.
Description of measurement methods and procedures to be applied	According to "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (Version 02), the CO_2 emission coefficient *(COEFi,y) is calculated based on net calorific value and CO2 emission factor of the fuel type i.*
Frequency of monitoring/recording	-
Value applied:	Not available for ex-ante calculation
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of Data	Calculation of project emissions
Calculation method	According to "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (Version 02), the CO2 emission coefficient (COEFi,y) is calculated based on net calorific value and CO2 emission factor of the fuel type i, as follows: $COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$ where $NCV_{i,y}$ = The weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit) $EF_{CO2,i,y}$ = The weighted average CO_2 emission factor of fuel type i in year y (tCO_2/GJ)

Item	Detail
$NCV_{i,y}$	Default NCV value in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.2. (Appendix A)
$EF_{CO2,i,y}$	Default $EF_{CO2,i,y}$ value in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.4. (Appendix A)

Comments	Update default value based on current version of IPCC Guidelines for National Greenhouse Gas Inventories

Data / Parameter	$T_{i.,y}$
Data unit	ton
Description	Amount of liquid fuel transported in trucks (baseline transportation mode) in route j in year x
Source of data	Measurements
Description of measurement methods and procedures to be applied	The amount of liquid fuel transported in route j in year x is recorded from on-line measure (SCADA) at the pipeline outlet stations. Route: Tj_1 — Amount of liquid fuel transported in trucks in route from Bang-Pa-In depot in Ayuthaya province, to Lampang depot in Lampang province; Tj_2 — Amount of liquid fuel transported in trucks in route from Bang-Pa-In depot in Ayuthaya province, to Phichit depot in Phichit province
Frequency of monitoring/recording	Monitoring: each liquid fuel batch Recording: monthly
Value applied:	For the ex-ante calculation, historical data of fuel transport to the North of Thailand from the project participants during Jan-Dec 2016 are used as the base year and then, estimation of forecasted number based on the study of Department of Energy Business, Ministry of Energy, Thailand are applied, and the forecasted amount of liquid fuel transported are present below.
Monitoring equipment	Turbine flow meter from Emerson/Daniel 1500 Series

Route	ton
Tj_1	211,160.72
Tj_2	714,775.14

QA/QC procedures to be applied	The meter is calibrated yearly to ensure the accuracy of measurement
Purpose of data	Calculation of baseline emissions
Calculation method	-
Comments	-

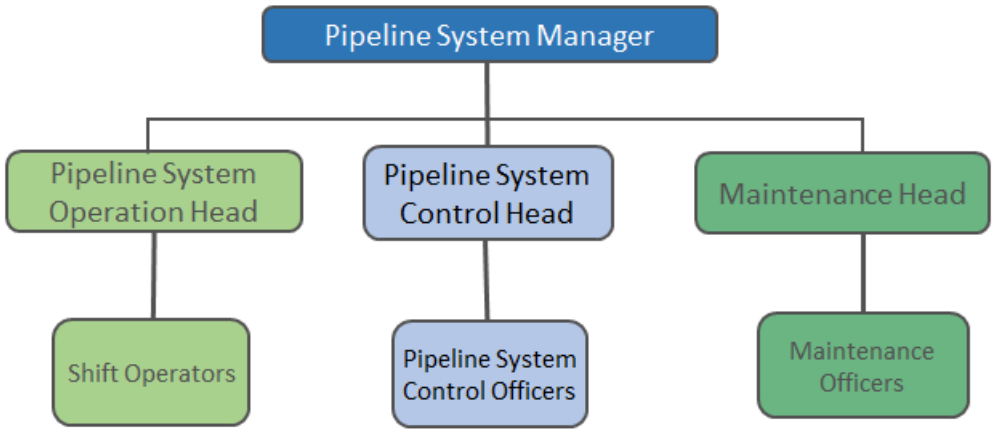
Data / Parameter	$FC_{i, j, y}$
Data unit	Ton
Description	Quantity of fuel type consumption in process j during the year y
Source of data	Fuel invoice from fuel supplier Note: there is no ex-ante calculation
Description of measurement methods and procedures to be applied	Amount of fuel consumption in the project activity.
Frequency of monitoring/recording	Monthly
Value applied:	-
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

Data / Parameter	$EC_{p,y}$
Data unit	MWh
Description	Quantity of electricity consumed by the project activity in year y
Source of data	Measure by electrical power meter
Description of measurement methods and procedures to be applied	Amount of electricity consumption (for high pressure pumps) and its measurement by electrical power meter
Frequency of monitoring/recording	Monthly

Value applied:	-
Monitoring equipment	Electrical meter: Elite 400
QA/QC procedures to be applied	The meter is IEC61010-1, IS14697, and IEC62053 certified and will be calibrated yearly basis based on manufacturer
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

5.3 Monitoring Plan

The organization chart of operational and management structure that will be implemented in order to track and monitor emission reductions from the project activity is shown in Figure below.



Position	Responsibility
Pipeline system manager	Oversee all monitoring and reporting data for GHG emission reduction calculation.
Pipeline system control and operation head	-Final review all monitoring and reporting data for GHG emission reduction calculation. Operation head will also act as QA/QC manager and be responsibility for preparation of the monitoring report. -Ensure plant system performance -Ensure effective data recording system -Ensure to record data on electricity and fuel consumptions from the invoice monthly

Position	Responsibility
Maintenance officers	- Maintain main equipment of the pipeline system. - Maintain operation of data recording system. - Ensure calibration of all VCS related equipment - Maintain of all VCS related equipment.
Pipeline system control officers	- Operate main equipment of the pipeline system - Maintain operation of data recording system.
Shift operators	Recording of monitoring data and submit draft report for Pipeline system control and operation head to review.

Under the supervision of the managing team, the pipeline system control and operation head will be responsible for data monitoring. All data will be recorded with reference to the data archiving procedures and kept in a systematic and transparent manner. The report will be verified and approved by the head of control and operation section. The head section will also have the responsibility to consolidate and report data to the operation and maintenance manager directly.

FPT has preventive maintenance measures laid out clearly, with responsible person assigned, duration and units identified. Key items noted include: Pipeline Pump & Motor, MOV Valve, Pressure Control Valve and Controller, SCADA system, and metering.

To substantiate, there are pipeline maintenance and monitoring processes in the duration of FPT operations. Maintenance officers are to consistently examine pipelines, with an emphasis in pipeline surface coating, pipe joints and main valve checks, including inspection of piping areas and other obstacles at hand. Following practices are expected:

1) Monitoring for pipeline cracks through inspection of pipeline areas and signs illustrating pipeline locations

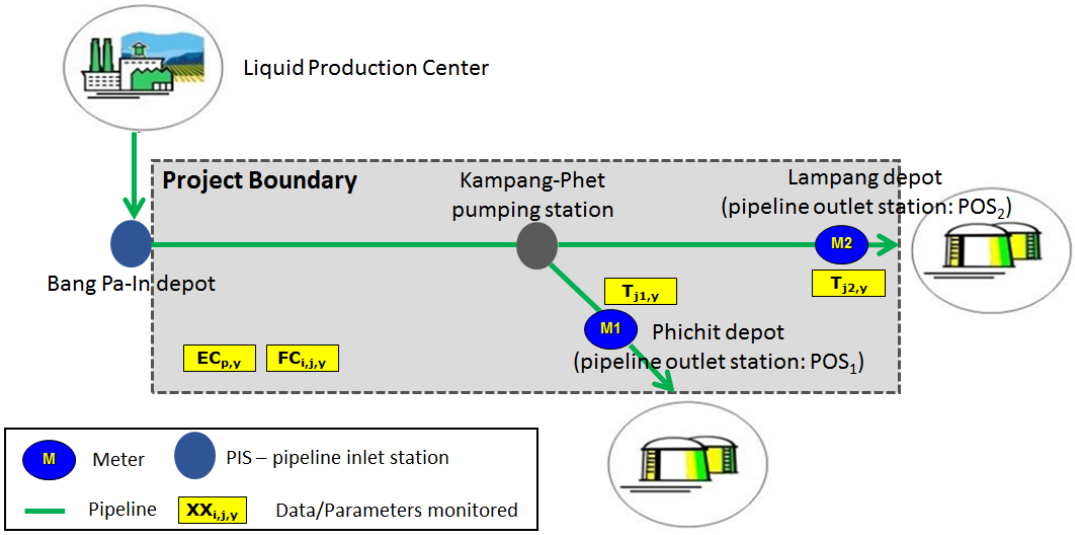
2) Pipeline maintenance by inspection and identification of pipeline collapses and soil erosion in area of soft soil, a steep path, or one with running water, in accordance to the standards.

3) Inspect for pipeline cracks by monitoring pipeline coating failures

4) Maintenance of erosion preventing systems, such as monitor the level of voltage used to protect against pipeline erosion, monitor the pipeline erosion, monitor electricity allocation system feeding to Cathodic protection system

Additionally, FPT has internal pipeline inspection gauge (PIG): There are cleaning PIG used to maintain the pipeline's internal cleanliness; gauging PIG to inspect internal abnormalities, and intelligence PIG to inspect the safety, the surface, the state and the location of pipeline.

The parameters measured are shown in Figure below.Inter



APPENDIX

- Default NCV value in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.2.
- Default $EF_{CO2,i,y}$ value in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 Energy, Chapter 1 Introduction, Table 1.4.

TABLE 1.2
DEFAULT NET CALORIFIC VALUES (NCVS) AND LOWER AND UPPER LIMITS OF THE 95% CONFIDENCE INTERVALS [1]

Fuel type English description		Net calorific value (TJ/Gg)	Lower	Upper
Crude Oil		42.3	40.1	44.8
Orimulsion		27.5	27.5	28.3
Natural Gas Liquids		44.2	40.9	46.9
Gasoline	Motor Gasoline	44.3	42.5	44.8
	Aviation Gasoline	44.3	42.5	44.8
	Jet Gasoline	44.3	42.5	44.8
Jet Kerosene		44.1	42.0	45.0
Other Kerosene		43.8	42.4	45.2
Shale Oil		38.1	32.1	45.2
Gas/Diesel Oil		43.0	41.4	43.3
Residual Fuel Oil		40.4	39.8	41.7
Liquefied Petroleum Gases		47.3	44.8	52.2
Ethane		46.4	44.9	48.8
Naphtha		44.5	41.8	46.5
Bitumen		40.2	33.5	41.2
Lubricants		40.2	33.5	42.3
Petroleum Coke		32.5	29.7	41.9
Refinery Feedstocks		43.0	36.3	46.4
Other Oil	Refinery Gas [2]	49.5	47.5	50.6
	Paraffin Waxes	40.2	33.7	48.2
	White Spirit and SBP	40.2	33.7	48.2
	Other Petroleum Products	40.2	33.7	48.2
Anthracite		26.7	21.6	32.2
Coking Coal		28.2	24.0	31.0
Other Bituminous Coal		25.8	19.9	30.5
Sub-Bituminous Coal		18.9	11.5	26.0
Lignite		11.9	5.50	21.6
Oil Shale and Tar Sands		8.9	7.1	11.1
Brown Coal Briquettes		20.7	15.1	32.0
Patent Fuel		20.7	15.1	32.0
Coke	Coke Oven Coke and Lignite Coke	28.2	25.1	30.2
	Gas Coke	28.2	25.1	30.2
Coal Tar [3]		28.0	14.1	55.0
Derived Gases	Gas Works Gas [4]	38.7	19.6	77.0
	Coke Oven Gas [5]	38.7	19.6	77.0
	Blast Furnace Gas [6]	2.47	1.20	5.00
	Oxygen Steel Furnace Gas [7]	7.06	3.80	15.0
Natural Gas		48.0	46.5	50.4
Municipal Wastes (non-biomass fraction)		10	7	18
Industrial Wastes		NA	NA	NA
Waste Oil [8]		40.2	20.3	80.0
Peat		9.76	7.80	12.5

TABLE 1.2 (CONTINUED)
DEFAULT NET CALORIFIC VALUES (NCVS) AND LOWER AND UPPER LIMITS OF THE 95% CONFIDENCE INTERVALS [1]

Fuel type English description		Net calorific value (TJ/Gg)	Lower	Upper
Solid Biofuels	Wood/Wood Waste [9]	15.6	7.90	31.0
	Sulphite lyes (black liquor) [10]	11.8	5.90	23.0
	Other Primary Solid Biomass [11]	11.6	5.90	23.0
	Charcoal [12]	29.5	14.9	58.0
Liquid Biofuels	Biogasoline [13]	27.0	13.6	54.0
	Biodiesels [14]	27.0	13.6	54.0
	Other Liquid Biofuels [15]	27.4	13.8	54.0
Gas Biomass	Landfill Gas [16]	50.4	25.4	100
	Sludge Gas [17]	50.4	25.4	100
	Other Biogas [18]	50.4	25.4	100
Other non-fossil fuels	Municipal Wastes (biomass fraction)	11.6	6.80	18.0

Notes:

[1] The lower and upper limits of the 95 percent confidence intervals, assuming lognormal distributions, fitted to a dataset, based on national inventory reports, IEA data and available national data. A more detailed description is given in section 1.5.

[2] Japanese data; uncertainty range: expert judgement

[3] EFDB; uncertainty range: expert judgement

[4] Coke Oven Gas; uncertainty range: expert judgement

[5-7] Japan and UK small number data; uncertainty range: expert judgement

[8] For waste oils the values of "Lubricants" are taken

[9] EFDB; uncertainty range: expert judgement

[10] Japanese data ; uncertainty range: expert judgement

[11] Solid Biomass; uncertainty range: expert judgement

[12] EFDB; uncertainty range: expert judgement

[13-14] Ethanol theoretical number; uncertainty range: expert judgement;

[15] Liquid Biomass; uncertainty range: expert judgement

[16-18] Methane theoretical number uncertainty range: expert judgement;

TABLE 1.4
DEFAULT CO_2 EMISSION FACTORS FOR COMBUSTION [1]

Fuel type English description		Default carbon content (kg/GJ)	Default carbon oxidation factor	Effective CO_2 emission factor (kg/TJ) [2]		
				Default value [3]	95% confidence interval	
		A	B	C=A*B*44/12*1000	Lower	Upper
Crude Oil		20.0	1	73 300	71 100	75 500
Orimulsion		21.0	1	77 000	69 300	85 400
Natural Gas Liquids		17.5	1	64 200	58 300	70 400
Gasoline	Motor Gasoline	18.9	1	69 300	67 500	73 000
	Aviation Gasoline	19.1	1	70 000	67 500	73 000
	Jet Gasoline	19.1	1	70 000	67 500	73 000
Jet Kerosene		19.5	1	71 500	69 700	74 400
Other Kerosene		19.6	1	71 900	70 800	73 700
Shale Oil		20.0	1	73 300	67 800	79 200
Gas/Diesel Oil		20.2	1	74 100	72 600	74 800
Residual Fuel Oil		21.1	1	77 400	75 500	78 800
Liquefied Petroleum Gases		17.2	1	63 100	61 600	65 600
Ethane		16.8	1	61 600	56 500	68 600
Naphtha		20.0	1	73 300	69 300	76 300
Bitumen		22.0	1	80 700	73 000	89 900
Lubricants		20.0	1	73 300	71 900	75 200
Petroleum Coke		26.6	1	97 500	82 900	115 000
Refinery Feedstocks		20.0	1	73 300	68 900	76 600
Other Oil	Refinery Gas	15.7	1	57 600	48 200	69 000
	Paraffin Waxes	20.0	1	73 300	72 200	74 400
	White Spirit & SBP	20.0	1	73 300	72 200	74 400
Other Petroleum Products		20.0	1	73 300	72 200	74 400
Anthracite		26.8	1	98 300	94 600	101 000
Coking Coal		25.8	1	94 600	87 300	101 000
Other Bituminous Coal		25.8	1	94 600	89 500	99 700
Sub-Bituminous Coal		26.2	1	96 100	92 800	100 000
Lignite		27.6	1	101 000	90 900	115 000
Oil Shale and Tar Sands		29.1	1	107 000	90 200	125 000
Brown Coal Briquettes		26.6	1	97 500	87 300	109 000
Patent Fuel		26.6	1	97 500	87 300	109 000
Coke	Coke oven coke and lignite Coke	29.2	1	107 000	95 700	119 000
	Gas Coke	29.2	1	107 000	95 700	119 000
Coal Tar		22.0	1	80 700	68 200	95 300
Derived Gases	Gas Works Gas	12.1	1	44 400	37 300	54 100
	Coke Oven Gas	12.1	1	44 400	37 300	54 100
	Blast Furnace Gas [4]	70.8	1	260 000	219 000	308 000
	Oxygen Steel Furnace Gas [5]	49.6	1	182 000	145 000	202 000

TABLE 1.4 (CONTINUED)
DEFAULT CO_2 EMISSION FACTORS FOR COMBUSTION [1]

Fuel type English description		Default carbon content (kg/GJ)	Default carbon oxidation Factor	Effective CO_2 emission factor (kg/TJ) [2]		
				Default value	95% confidence interval	
		A	B	C=A*B*44/12*1000	Lower	Upper
Natural Gas		15.3	1	56 100	54 300	58 300
Municipal Wastes (non-biomass fraction)		25.0	1	91 700	73 300	121 000
Industrial Wastes		39.0	1	143 000	110 000	183 000
Waste Oil		20.0	1	73 300	72 200	74 400
Peat		28.9	1	106 000	100 000	108 000
Solid Biofuels	Wood/Wood Waste	30.5	1	112 000	95 000	132 000
	Sulphite lyes (black liquor)[5]	26.0	1	95 300	80 700	110 000
	Other Primary Solid Biomass	27.3	1	100 000	84 700	117 000
	Charcoal	30.5	1	112 000	95 000	132 000
Liquid Biofuels	Biogasoline	19.3	1	70 800	59 800	84 300
	Biodiesels	19.3	1	70 800	59 800	84 300
	Other Liquid Biofuels	21.7	1	79 600	67 100	95 300
Gas biomass	Landfill Gas	14.9	1	54 600	46 200	66 000
	Sludge Gas	14.9	1	54 600	46 200	66 000
	Other Biogas	14.9	1	54 600	46 200	66 000
Other non-fossil fuels	Municipal Wastes (biomass fraction)	27.3	1	100 000	84 700	117 000

Notes:

[1] The lower and upper limits of the 95 percent confidence intervals, assuming lognormal distributions, fitted to a dataset, based on national inventory reports, IEA data and available national data. A more detailed description is given in section 1.5

[2] TJ = 1000GJ

[3] The emission factor values for BFG includes carbon dioxide originally contained in this gas as well as that formed due to combustion of this gas.

[4] The emission factor values for OSF includes carbon dioxide originally contained in this gas as well as that formed due to combustion of this gas

[5] Includes the biomass-derived CO_2 emitted from the black liquor combustion unit and the biomass-derived CO_2 emitted from the kraft mill lime kiln.