CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

Annexes

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1 Title of the small-scale project activity:

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"Afyonkarahisar Landfill Gas to Electricity Project, Turkey"

Version No	Date	Description and reason of revision
01	16 January 2012	Prepared PDD for DOE

A.2. Description of the small-scale project activity:

Arel Çevre Yatırımları ve Enerji Üretim Tic. Ltd. Sti. (Arel Enerji) plans to invest into a biogas power plant to generate electricity and feed it into the Turkish grid. The biogas power project is plant to be built in the province of Afyonkarahisar in Turkey with 1.24 MWm capacity. The project aims at avoiding greenhouse gas (GHG) emissions from existing landfill area by collecting biogas to generate electricity. Thus, in addition to the direct avoidance of GHG emissions, further indirect emission reductions are achieved through the CO_2-neutral replacement of fossil fuels used for power generation.
The Gold Standard organization sets a framework – following the schemes defined by the Kyoto-Protocol for the international trading of emission reductions – for the generation and trading of certificates attesting emission reductions achieved by a project. The Gold Standard VER approach is applicable in countries that are not subject to a GHG emission target defined in the Kyoto-Protocol.
Construction work for project started in the beginning of October 2011. From March of 2012 on, Afyonkarahisar Landfill Gas to Electricity project (the proposed project) is planned to produce electricity by using landfill gas, which creates fire and public health risks.
The activity includes installation of landfill gas extraction system, an enclosed flare as well as a biogas driven genset for electricity production. The extraction system shall include a network of vertical gas extraction wells, de-watering units and gas transport pipelines connected to a main collector system. The gas will be driven to gas engine and the flare via an aspiration system.

Contribution to sustainable development

Environmental, socio-economic and technological benefits of the project are described as follows:

- Reduction in fossil fuel use (imported or local) by using renewable energy resources,
- Reduction in greenhouse gas emissions from the landfill area by using biogas for electricity production,
- Reduction in energy production costs and imported energy amounts,
- Improvement of environmental conditions (GHG and odour) and safety in the landfill area.

A.3. Project participants:

Project participants and Parties involved are listed in table 1.

Table 1: Project Participants Information

Name of Party involved (*) (host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Turkey (host country)	Arel Çevre Yatırımları ve Enerji Üretim Tic. Ltd. Sti.	No

Arel Çevre Yatırımları ve Enerji Üretim Tic. Ltd. Sti. (Arel) is private project developer and owner of the project.

The Republic of Turkey is the host country. Turkey ratified the Kyoto Protocol (on 5th February of 2009) and put in effect on 13th May 2009[1]. Turkish National Focal Point to the UNFCCC is the Ministry of Environment and Forestry[2].

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

A.4.1.1. Host Party(ies):

The host country is Republic of Turkey.

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

The project will be situated within the borders of Afyonkarahisar province of Turkey.

A.4.1.3. City/Town/Community etc:

The project will be situated within the borders of Afyonkarahisar city, in Akçin village, 10 km from the city center. The landfill area serves approximately 420,000 people.

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[1] See, Official Gazette: http://rega.basbakanlik.gov.tr/main.aspx?home=http://rega.basbakanlik.gov.tr/eskiler/2009/05/20090513.htm&main=http://rega.basbakanlik.gov.tr/eskiler/2009/05/20090513.htm (link in 'Milletlerarası Sözleşme' part)

[2] See, UNFCCC, list of the National Focal Points: http://maindb.unfccc.int/public/nfp.pl?mode=wim

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

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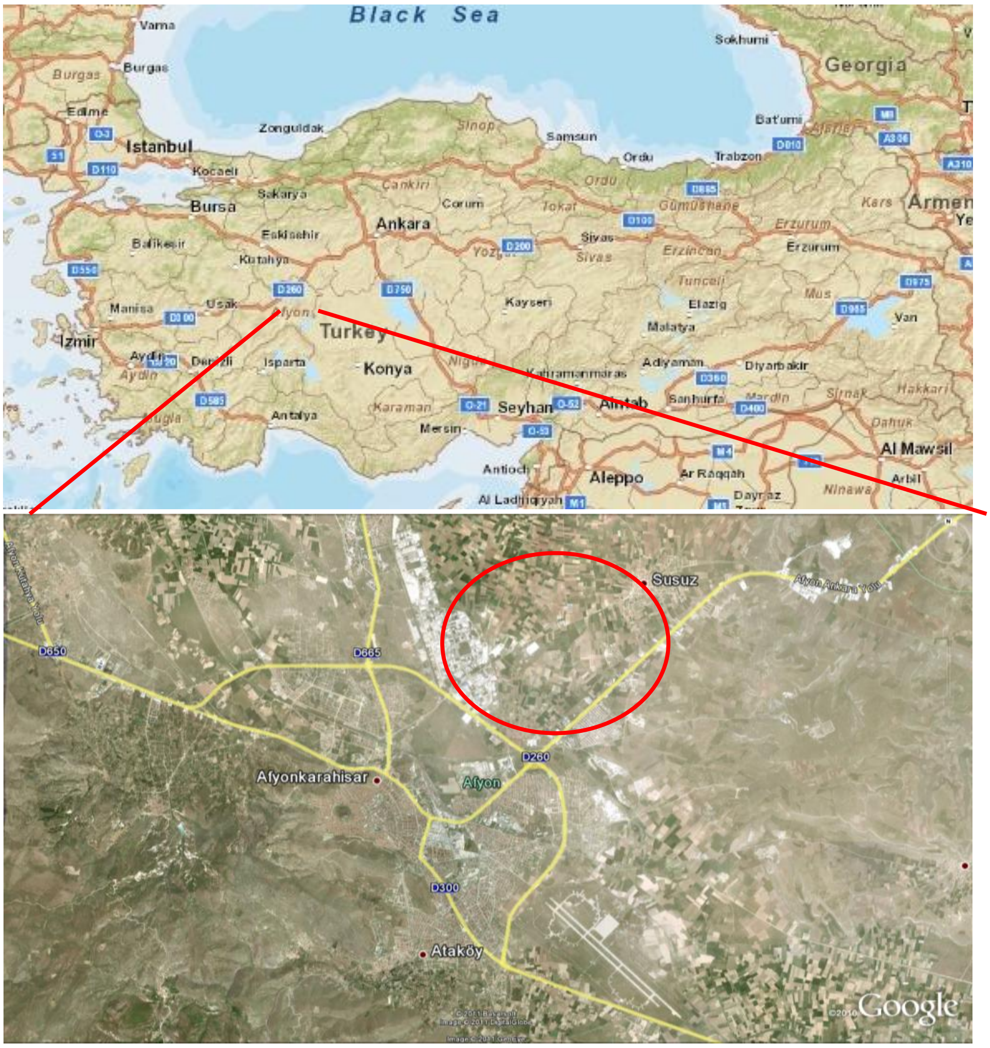
The project site is located within the borders of Afyonkarahisar city, in Akçin village . Location of the project is given below in the Map 1.



Map 1: ***Location of the Project Area in , Turkey***

The geographical coordinates of the main bodies of the project activity are presented in the table below.

Table 1: ***Geographical coordinates of the two main project bodies***

Bodies of the Project	Latitude (N)	Longitude (E)
Landfill gas plant	38°47'29.19"	30°34'17.69"

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

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Sectoral Scope 13: **Waste Handling and Disposal**

The scope of the project activity is waste management, where the emission baseline is the amount of methane that would be emitted to the atmosphere during the crediting period in the absence of the project activity. The captured gas is used to produce energy. Thus, Type III- other project activities and category G- Landfill methane recovery; and

Sectoral Scope 1: **Energy Industries**

Project activity includes electrical energy production from the collected landfill gas, which is to be used in a first instance to cover the electrical on-site demand. Excess electricity will be fed into the national grid. Thus, Type I- Renewable energy project and category D- Grid connected renewable electricity generation.

Technology to be employed:

The Afyonkarahisar Landfill Project aims at the reduction of methane gas generated at the Afyonkarahisar landfill by combusting the collected gas in an engine to generate electricity. The landfill has started its operation in 2009. By the implementation of the project, a gas extraction and control system will be implemented. The control activities include periodic adjustment of the gas wells by means of measuring equipment - gas flow, methane content and oxygen content are very important parameters (landfill gas may form an explosive mixture when it combines with air in certain proportions; methane is explosive between its LEL[3] of 5% by volume and its UEL[3] of 15% by volume).

Table 2: Amount of the wastes disposed to the sites[4]

Years	Disposal of Wastes (t)	Efficiency of Degassing
2009	31.770	60 %
2010	128.845	
2011	136.875	
2012	139.613	
2013	142.405	
2014	145.253	
2015	148.158	
2016	151.121	
2017	154.143	
2018	157.226	

The gas extraction plant is equipped with aspirators that create a suction vacuum in the system necessary for LFG extraction (aspiration system). Landfill gas is used for electricity generation and excess gas is flared in a high temperature flare (800-1200 °C, retention time 0.3 s). An emergency genset will be available for start-up of the biogas engine. The produced energy will be fed into the national grid.

[3] LEL= Lower explosive limits, UEL= Upper explosive limits

[4] Feasibility of the Project, page 7, 14

The projected plant operates by an electrical control system equipped with a monitoring control system for methane, oxygen, flow, pressure and temperature. In the initial phase, the installed equipment is estimated to extract about 60% of the total produced LFG. The extraction efficiency may gradually increase.

A.4.3 Estimated amount of emission reductions over the chosen crediting period:

The proposed project activity adopts a fixed crediting period, i.e. 7 years (01/3/2012-28/02/2019); estimated emission reductions during each year are presented in the following table:

Table 3: Estimated amount of emission reduction over the crediting period

Years	Annual estimation of emission reductions [tCO_2e]
(March-December) 2012	13.100
2013	20.314
2014	24.754
2015	29.052
2016	33.218
2017	37.261
2018	41.142
(January-March) 2019	7.495
Total emission reductions (tonnes of CO_2e)	**206,336**
Total number of crediting years	7
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**29,477**

A.4.4. Public funding of the small-scale project activity:

The project activity does not receive any public funding or Official Development Assistance (ODA) funding.

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

Following the '*Determining the Occurrence of Debundling*' decision tree in '*Compendium of guidance on the debundling for SSC project activities*'[5] (which is referred by Appendix C of the simplified modalities and procedures for the small-scale CDM project activities), since proposed project activity is

[5] See, http://cdm.unfccc.int/Reference/Guidclarif/ssc/methSSC_guid17_v01.pdf (page 4)

the first emission reduction (VER) project of proposed project participant Arel Enerji, there is not any registered Small Scale CDM (or VER) project activity of proposed project participant and therefore the proposed Small Scale project activity is not deemed to be a debundled component of a large 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 small-scale project activity:

Applied approved baseline and monitoring methodologies:
AMS-III.G. Landfill methane recovery (version 07)
AMS-I.D. Grid connected renewable electricity generation (version 16)

Used tools:
"Tool for the demonstration and assessment of additionality" (Version 6.0.0)
"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (version 6.0.0)
"Tool to calculate the emission factor for an electricity system" (version 02.2.1)
"Tool to determine project emissions from flaring gases containing Methane"

The above methodologies and tools are available at:
http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html

B.2 Justification of the choice of the project category:

General small scale requirement for chosen Type III component:3
The expected aggregate emission reductions of the proposed project activity from all type III components are less than 60kt CO2 equivalent annually, the detailed figure please refer to section B.6.3. and B.6.4

General small scale requirement for chosen Type I component:4
The total capacity of the 1 installed engines for the proposed project activity is 1.2 MWe, which is less than 15 MW. Together with the condition above, the conclusion can be drawn that the proposed project activity will remain under the limits of small scale project activity types during every year of the crediting period.
The methodologies AMS-III.G and AMS-I.D are applicable for the proposed small scale project activity, since the requirements of these methodologies are met, as summarized in the Table below:

Tablo 4: Applicability comparison between methodology and the proposed project activity

Methodology applicability	The proposed project activity
AMS-III.G (version 06)	
1. This project category comprises measures to capture and combust methane from landfills (i.e., solid waste disposal sites) used for disposal of residues from human activities including	*The proposed project activity will recover LFG generated from a municipal solid waste disposal site*

municipal, industrial and other solid wastes containing biodegradable organic matter	
2. The recovered methane from the above measures may also be utilised for the following applications instead of flaring or combustion a. Thermal or electrical energy generation directly; or b. Thermal or electrical energy generation after bottling of upgraded biogas; or c. Thermal or electrical energy generation after upgrading and distribution using one of the following options: (i) Upgrading and injection of biogas into a natural gas distribution grid with no significant transmission constraints; or (ii) Upgrading and transportation of biogas via a dedicated piped network to a group of end users; or Hydrogen production.	*The proposed project activity will utilize the recovered LFG to produce electrical energy directly, i.e. 2 (a)*
3. If the recovered methane is used for project activities covered under paragraph 2(a), that component of the project activity shall use a corresponding category under type I.	*The electricity produced by the proposed project activity will be exported to the Grid, so AMS-I.D will be adopted.*
AMS-I.D (version 16)	
1. This category comprises renewable energy generation units, such as photovoltaics, hydro, tidal/wave, wind, geothermal and renewable biomass that supply electricity to a national or a regional grid..	*The proposed project activity will feed the electricity produced by LFG, one of the renewable energies, into the Turkish Power Grid, which is connected to more than one fossil fuel fired generating unit.*

B.3. Description of the project boundary:

According to the methodology, the project boundary is the site where the gas is captured and destroyed/used. For the proposed project activity, electricity will not be sourced from the grid or from power generation sources. Furthermore, it will not be sourced from a captive generation source or power plant. The project boundary is the Afyonkarahisar landfill site where the landfill gas (LFG) is extracted and destroyed by flaring and partially used for electricity generation.

The boundary of the proposed project is shown in Figure 1. It identifies as the physical, geographical site of the landfill where gas is captured and destroyed/ used, including LFG collection system, power generation system, auxiliary equipment, etc.

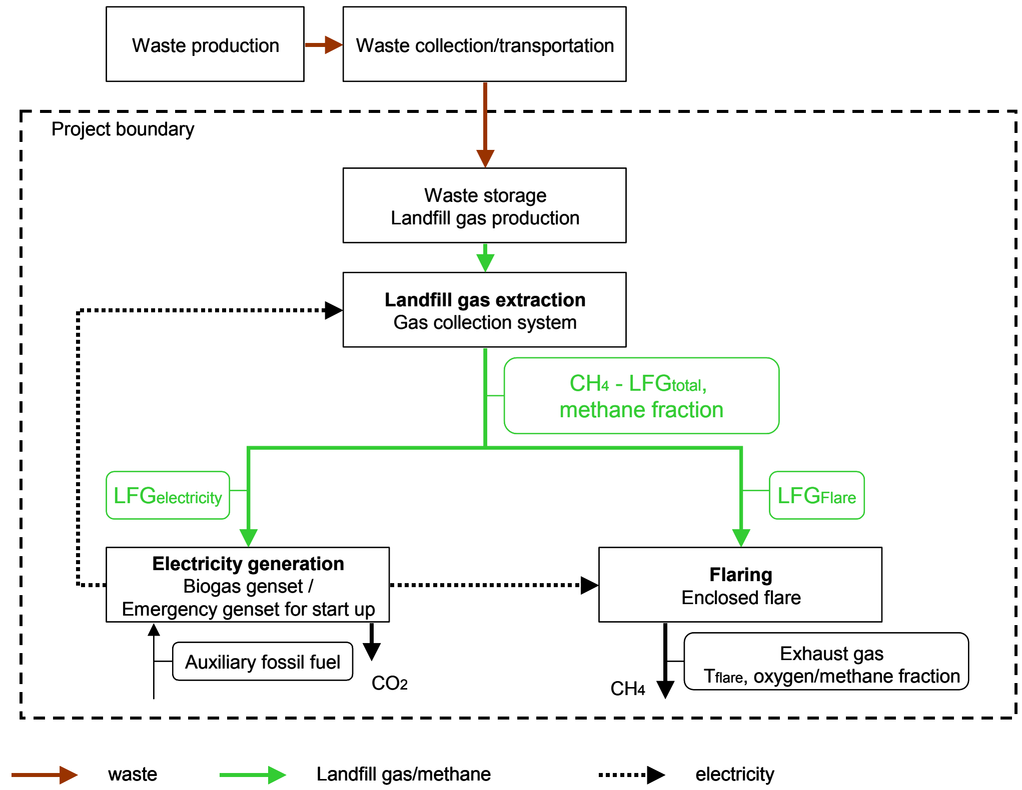


Figure 1 Flow diagram of project boundary

The emission within the Project boundary is defined in table 6 below:

Table 5: Emissions within project boundary

	Source	**Gas**	**Included**	**Justification/Explanation**
Baseline	Emissions from decomposition of waste at the landfill site	CO_2	No	According to the methodology CO_2 emissions from the decomposition of organic waste are not accounted for.
		CH_4	Yes	Major source of emissions in the baseline. Emissions are caused by the degradation of organic wastes.
		N_2O	No	Minor source - excluded for simplification. Exclusion is conservative.
	Emissions from electricity consumption	CO_2	No	There are no buildings within the landfill site that use electricity and heat.
		CH_4	No	Minor source - excluded for simplification.

		N_2O	No	Minor source - excluded for simplification.
	Emissions from thermal energy generation	CO_2	No	Thermal energy generation is not included in the project activity
		CH_4	No	Thermal energy generation is not included in the project activity
		N_2O	No	Thermal energy generation is not included in the project activity
Project Scenario	Emissions from on-site electricity use	CO_2	No	Electricity generated from the collected LFG will be used to cover the demand on the site.
		CH_4	No	Minor source - excluded for simplification.
		N_2O	No	Minor source - excluded for simplification.
	On-site fossil fuel consumption due to the project activity other than electricity generation	CO_2	Yes	Diesel is used as auxiliary fuel. Emissions are expected to be less than 0,1% of emission reductions under normal operating conditions.
		CH_4	No	Minor source - excluded for simplification.
		N_2O	No	Minor source - excluded for simplification.

B.4. Description of baseline and its development:

In accordance with AMS-III.G. (Version 07), the baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere. Baseline emissions shall exclude methane emissions that would have to be removed to comply with national or local safety requirement or legal regulations.

Besides, according to the methodology AMS-I.D, if the recovered methane from landfill gas is used for electricity generation, the baseline emissions are the electricity produced by the renewable generating unit multiplied by the grid emission factor. Since the electricity produced by the proposed project will be exported to Turkish National Grid which is mainly based on thermal power plants using fossil fuels, the baseline scenario for electricity replacement is product of electricity energy baseline expressed in kWh of electricity produced by the renewable generating unit multiplied by an emission factor. Combined margin (CM) is adopted for emission factor.

Therefore as explained above, baseline emission for the Landfill Gas Project is:

A. Landfill Gas: In the absence of the project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere

B. Electricity: Product of electricity energy baseline expressed in kWh of electricity produced by the renewable generating unit multiplied by an emission factor. Combined margin (CM) is adopted for emission factor

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 small-scale CDM project activity:

Although the project is small scale, in accordance to the Gold Standard Rules I.b.1, the "Tool for the demonstration and assessment of additionality" (Vers. 6.0.0, EB 65) is applied. The tool provides an explanation how the project activity will lead to emission reductions that would be additional to the baseline scenario, described in B.1.

Evaluation of the alternatives is based on economic attractiveness and other critical considerations. The project proponent carried out a complete analysis among the credible and realistic alternatives based on the following key parameters:
1. Legal framework;
2. Possible Barriers;
3. Other important considerations in order to determine the baseline and additionality.

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a: ***Alternatives to the project activity***

To identify the realistic and credible alternative scenario(s) for project participants, scenarios in the Tool are assessed:

P1: The proposed project activity undertaken without being registered as a GS VER project activity

This alternative is realistic and credible as Arel Enerji may undertake project activity if he sees no risk for project and/or if the project turns out to be financially attractive without GS VER credit income. However, investments analyze shows that the project is not economically feasible without GS VER credit income. Detail information is given in Step-2c and 2d.

P2: Continuation of the current situation, i.e. Afyonkarahisar Landfill is not built

The decision in favour or against a project investment depends on the expected revenues and risks, like for every other private investment. Investment decisions other than Afyonkarahisar Landfill are independent from the question whether Afyonkarahisar Landfill is built or not. This alternative is also realistic and credible.
According to baseline scenario which is described in B.4, there is a need for energy investment to satisfy increasing demand and if the Afyonkarahisar Landfill is not built, the same amount of energy will be supplied by other private investors to the grid. Forecasts shows that electricity supplied in the absence of

Afyonkarahisar Landfill will be mainly based on fossil fuels as the projections for the year of 2018 forecasts 75% share for fossil fuels in the energy mix.
Moreover in the case of Afyonkarahisar Landfill is not built, the methane that is produce as a result of disposed waste will be emitted to the atmosphere.

P3: Other realistic and credible alternative scenario(s) to the proposed GS VER project activity scenario that deliver electricity with comparable quality, properties and application areas, taking into account, where relevant, examples of scenarios identified in the underlying methodology;

The project activity is power generation activity without any greenhouse gas emission harnessing the energy of the wind. Being a private entity, Arel Enerji doesn't have to invest power investments even proposed project activity. Also, since Arel Enerji has license only for landfill power investment and since in the proposed project area there is no hydro or other sources for electricity generation, other project activities delivering same electricity in the same project area is *not* realistic for project participant.

Therefore, two realistic and credible alternative scenarios are identified for the project activity:

P1: The proposed project activity undertaken without being registered as a GS VER project activity.
P2: Continuation of the current situation, i.e. Afyonkarahisar Landfill is not built.

Sub-step 1b: Consistency with mandatory applicable laws and regulations

Both alternatives are in compliance with the following identified applicable mandatory laws and regulations. The most common means of waste management in Turkey is unmanaged landfilling. Most of the existing landfill sites are uncontrolled, exceeding the maximal volumes of waste allowed to be disposed.

Since Turkey seeks to join European Union, the Government has started to create strategic development plans for the waste sector. A national programme on waste management concept was adopted in 2008[6]. The programme defines basic principles and legal framework for waste management and gives action plans for each province.

Laws and regulations regarding waste management and electricity generation are given below. The regulations on waste management require precautions to prevent explosion of landfill gas but does not require recovery or destruction of it.

Legal aspects of air protection in Turkey	**Comment**
"Law on the Environment" dated 26.04.2006 numbered 2872 and	This law addresses the ecological security of the population, the rational use of natural resources, nature conservation and environmental protection. Additional Article 6 says that clean air

[6] http://www.cygm.gov.tr/CYGM/Files/EylemPlan/atikeylemplani.pdf

	policies should be applied in provinces and districts and air quality should be monitored. Methodologies for determination, monitoring and measurement of air quality, air quality limit values, precautions to prevent air pollution and public awareness are responsibilities of the Ministry of Environment and Forestry. No regulatory requirement for destruction of landfill gas.
"Regulation on general principles of waste management[7]" dated 05.07.2008 and numbered 26927	The regulation aims to determine general principles of waste management in order to protect the environment and human health from generation to disposal of waste. No regulatory requirement for destruction of landfill gas.
"Regulation on landfilling[8]" dated 26.03.2010 and numbered 27533	The regulation aims to protect of the environment by minimizing negative impacts of leachate and landfill gas on soil, air, underground and surface water No regulatory requirement destruction of landfill gas.
"Regulation on Control of Solid Waste[9]" dated 14.03.1991 and numbered 20814	The regulation aims to determine policies and programmes to prevent disposal, storage and transportation of waste in a way to harm biological and human environment. No regulatory requirement destruction of landfill gas.
Electricity Market Law[10] dated 20.02.2001 and numbered 03.03.2001	The Law aims to ensure the development of a financially sound and transparent electricity market operating in a competitive environment under provisions of civil law and the delivery of sufficient, good quality, low cost and environment-friendly electricity to consumers and to ensure the autonomous regulation and supervision of this market. No regulatory requirement for destruction of landfill gas.
Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electricity Energy[11] dated 10.05.2005 and numbered 5346	The purpose of this Law is to expand the utilization of renewable energy resources for generating electrical energy, to benefit from these resources in secure, economic and qualified manner, to increase the diversification of energy resources, to reduce greenhouse gas emissions, to assess waste products, to protect the environment and to develop the related manufacturing sector for realizing these objectives. The law brings an incentive of 13.3 $ cent/kWh for the electricity production from biomass. It also brings incentives for local local equipment purchase such as turbines, enginees, cogeneration systems etc.

[7] See: http://www.mevzuat.adalet.gov.tr/html/27906.html
[8] See: http://www.mevzuat.gov.tr/Metin.Aspx?MevzuatKod=7.5.13887&MevzuatIliski=0&sourceXmlSearch=
[9] See: http://www.mevzuat.adalet.gov.tr/html/20743.html
[10] See: http://www.epdk.gov.tr/mevzuat/kanun/elektrik/elektrik_piyasalari_kanunu.pdf
[11] See: http://www.epdk.gov.tr/documents/10157/4b360128-53aa-4174-8104-a6c10434ac9c

	No regulatory requirement for destruction of landfill gas.

Thus, as indicated by the law above, no regulatory requirement for destruction of landfill gas. Therefore, the baseline scenario of the proposed project is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere.

Project Implementation Schedule and Early Consideration of VER

Table 6: Implementation Schedule and Early Consideration of VER

Date (DD/MM/YYYY)	Activity
16/06/2011	Contract with the Municipality which considers carbon income
18/08/2011	First Proposal Request from VER Consultants
19/08/2011	Gas Engine contract date (Guascor – Alternatif Power)
01/10/2011	Starting Construction Activities with Roads and Site Preparation
13/10/2011	Signature with FutureCamp Turkey for VER Development
30/01/2012	Issuance of the License
28/02/2012	Planned Start of operation

According to Turkish regulations, to get necessary permits for further project implementation, granting generation license from Authority is required. Hence, issuance of license cannot be considered as 'Project Start Date' but a prerequisite to proceed for further project development activities. Date of contract for Gas Engine with Guascor shall be set as project starting date since, after this agreement 'Arel Enerji' committed to make considerable amount of investment for this project.

Above Implementation Schedule clearly shows that before starting to the project activity, 'Arel Enerji' started to analysis of revenue from VER credit sale decided to get consultancy for VER development and later made agreement with FutureCamp Turkey for carbon development. Moreover, the contract with municipality it is clearly stated that carbon income is considered by Municipality and investor.

In the following, the investment analysis is applied to clearly demonstrate that the project activity is unlikely to be financially/economically attractive without the revenue from the sale of VERs.

STEP 2: Investment analysis

This step will determine whether the proposed project activity is not the most economically or financially attractive or economically or financially feasible, without the revenue from the sale of verified emission reductions (VERs).

Sub-step 2a: Determine appropriate analysis method

There are three options that can be applied in investment analysis: simple cost anaylsis, simple cost analysis, investment comparison analysis or benchmark analysis. As the propose project has financial benefits (electricity sale) other than CDM related income, simple cost analysis cannot be applied. The investment comparison analysis is not applicable either, as the baseline scenario, providing the same electricity output is not a project with comparable investment data. Benchmark analysis will be used to determine if financial indicators of the proposed project is better than the benchmark value or not.

Sub-step 2b: Apply benchmark analysis

As a common means to evaluate the attractiveness of investment projects and compare them with possible alternatives, the IRR (Internal Rate of Return) shall be used. According to the "Tool for the demonstration and assessment of additionality", benchmark for investment analysis can be driven from '*Estimates of the cost of financing and* ***required return on capital based on bankers views*** *and private equity investors/funds*'. As a banker view, according to Worldbank loan appraisal document[12], threshold equity IRR for biomass investments (i.e. required returns of equity for biomass power investors) in Turkey is 20%.

Sub-step 2c: Calculation and comparison of the IRR

In the paragraph 11 of the 'Guidance on the Assessment of Investment Analysis'[13], it is stated that: 'Required/expected returns on equity are appropriate benchmarks for equity IRR'. Since, benchmark identified in the Sub-step 1b is required/expected returns on equity, equity IRR (before tax) of the project activity shall be calculated for the comparison. The IRR is calculated on the basis of expected cash flows (investment, operating costs and revenues from electricity sale), as used in the financial analysis for the feasibility assessment of the project. Main parameters for the calculation of IRR are:

- Capacity: 1.2 MWe
- Annual power generation: 9600 MWh
- Electricity tariff: 133 $/MWh

Electricity tariff of Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electricity Energy[14] is used in the IRR calculations. As the equipment in the project is imported, the incentive of the Law for local equipment purchase is not applicable. Other parameters and values used for the IRR calculation are available to DOE during validation. The resulting equity IRR for 10 years is stated in below table:

Table 7: Equity IRR for project activity

Period	IRR
10 years	9,56%

Without adding any risk premium to the benchmark, which is 20%, it does clearly exceed the resulting equity IRR, thus rendering the project activity economically unattractive.

[12] Worldbank - Project Appraisal Document on a IBRD Loan and a Proposed Loan from Clean Technology Fund to TSKB and TKB with the Guarantee of Turkey, May 2009 (http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2009/05/11/000333037_20090511030724/Rendered/PDF/468080PAD0P112101Official0Use0Only1.pdf page 80, paragraph 29 and page 81, Table 11.5)

[13] See, http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf (page 14)

[14] See: http://www.epdk.gov.tr/documents/10157/4b360128-53aa-4174-8104-a6c10434ac9c

Sub-step 1d: Sensitivity analysis

While the main parameter determining the income of the project is the electricity sales price, a variation of the accordant value shall demonstrate the reliability of the IRR calculation. Electricity price (EP) is varied with +/-10% from the max. feed-in-tariff, which is 133 $/MWh.

For Sensitivity Analysis, the investment amount, annual energy yield amount and operation cost parameters are varied with +/- 10%. The worst, base and best-case results for each parameter variation are given below, in **Hata! Başvuru kaynağı bulunamadı.**. The sensitivity analysis confirms that the proposed project activity is unlikely to be economically attractive without the revenues from VERs as even the maximum IRR result for the best case scenario (16.07 %) is below the benchmark, which is 20%. Best case scenario is not possible as the feed-in-tariff prices are fixed and determined by law.

Tablo 8: Equity IRR with different parameters*

Parameter	Investment Cost @ 55 €/MWh			Energy Yield @ 55 €/MWh			Operating Cost @ 55 €/MWh		
Variance	-10%	0%	10%	-10%	0%	10%	-10%	0%	10%
Equity IRR Before Tax - 10y	11,61%	9,56%	7,74%	6,27%	9,56%	12,61%	16,07%	9,56%	8,86%

* For other parameters than electricity price (EP), 133 $/MWh EP is applied.

Based on the above analysis, it can be concluded that the proposed Project is not financially attractive in the absence of VER revenue given the variation of four parameters in a range of -10%～+10%. Thus the Project is shown to be additional.

STEP 4: Common practice analysis.

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

Operational landfill energy projects in Turkey are given in 10 below:

Tablo 9: Landfill energy projects in Turkey

Company	Location	Installed Capacity (MW)	Brief description of the project	Business Model of the Project	GS Project ID[15]
Ekolojik Enerji Anonim Şirketi	İstanbul/ Kemerburgaz	5.826	Private owned gasification facility for hazardous wastes[16]	-	-
ITC-KA Enerji Üretim San. ve Tic. A.Ş.	Ankara/ Mamak	36	Private owned facility for biogas utilization from municipal waste[17]	VER	GS440

[15] For GS Projects See: https://gs1.apx.com/myModule/rpt/myrpt.asp?r=111
[16] http://www.ekolojikenerji.com.tr/tr/projeler/projeler-kemerburgaz.asp

Ortadoğu Enerji Sanayi ve Ticaret A.Ş.	İstanbul/ Şile	7.56	Private owned facility for biogas utilization from municipal waste[18]	VER	GS711
Ortadoğu Enerji Sanayi ve Ticaret A.Ş.	İstanbul/ Kemerburgaz	28.3	Private owned facility for biogas utilization from municipal waste[13]	VER	-
ITC-KA Enerji Üretim San. ve Tic. A.Ş.	Ankara/ Sincan	5.66	Private owned facility for biogas utilization from municipal waste[11]	VER	GS675

As it is shown in above table, ITC-KA Mamak, Ortadoğu Şile, Ortadoğu Kemerburgaz and ITC-KA Sincan are VER projects. So they are not considered in common practice analysis. Ekolojik Enerji Kemerburgaz is built on gasification technology[12] which if different technology of proposed project.

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

As it is shown in Sub-step 4a, there are no similar projects to the proposed project in Turkey. The technical and commercial risks are high for this project. Without GS-VERs income, the proposed project does not represent an attractive investment opportunity as it faces relevant barriers. Taking into consideration the significant technological and investment barriers, investors are unlikely to invest in the project in the absence of carbon finance.

The emissions reductions from the proposed project are therefore additional to what would have occurred in the absence of the GS-VER project activity.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The project, which implies recovery of methane and flaring only, applies the approved methodology AMS.III.G for Landfill Methane Recovery (Version 7) and AMS-I.D. Grid connected renewable electricity generation (version 16). As stated in the methodology, the emission reductions are estimated ex-ante and calculated ex-post as per two different formulae

A. Ex-ante emission reductions

<u>Baseline emissions</u>

Baseline emission are:

[17] http://www.itcturkiye.com/sunum.html
[18] http://www.ortadoguenerji.com.tr/index.php?copgazienerjisi=1

- Emissions from decomposition of waste at the landfill site
- Emissions resulting from electricity generation

$$BE_y = \left(BE_{\text{CH4,SWDS,y}} - MD_{reg,y}\right) + BE_{elec,BL,y} \qquad \textbf{(1)}$$

where

BE_y	baseline emissions in year y (t CO_2e)
$BE_{CH4,\ SWDS}$	Methane emission potential of a solid waste disposal site (in tCO2e), calculated using the 'Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site'. The tool may be used: • With the factor 'f=0.0' assuming that no methane is captured and flared; • With the definition of year x as 'the year since the landfill started receiving wastes, x runs from the first year of landfill operation (x=1) to the year for which emissions are calculated (x=y)'. The amount of waste type j deposited in each year x (Wj,x) shall be determined by sampling (as specified in the tool), in the case wastes are generated during the crediting period. Alternatively, for existing SWDS, if the pre-existing amount and composition of the wastes in the landfill are unknown, they can be estimated by using parameters related to the attended population or industrial activity, or by comparison with other landfills with similar conditions in regional or national levels
$MD_{reg,y}$	Methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year y (tCH4)
$BE_{elec,BL,y}$	Baseline emissions due to the use of grid electricity in year y, (tCO_2e)

There are no regulatory nor contractual requirements for methane destruction/combustion. There is also no LFG flared without the project activity, therefore $MD_{reg,y}$ equals zero.

A.1 Ex-ante estimation of the amount of methane that would have been destroyed /combusted duringthe year, in tonnes of methane (*project y MD* , **)**

For the *ex-ante* estimation of the amount of methane that would have been destroyed/ combusted during year *y*, it is assumed that only a percentage of gas generated on site can be captured and collected by the proposed project.

The ex-ante estimation of the amount of methane destroyed by the project activity $MD_{project,y}$ is based on the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (version 06.0.0, EB 65, Report Annex 19):

$$MD_{project,y} = BE_{CH4;SWDS,y} \qquad \textbf{(2)}$$

where

$MD_{project,y}$	the amount of methane that would have been destroyed /combusted during the year, in tonnes of methane
$BE_{CH4,SWDS,y}$	Methane generation from the landfill in the absence of the project activity at year y (t CO_2e)

A.2. Determination of $BE_{elec,BL,y}$ in equation (1) - Application of "Tool to calculate the emission factor for an electricity system"

According to the "Tool to calculate the emission factor for an electricity system" (Version 02.2.0), the following six steps are applied to determine the *OM*, *BM*, and *CM* used for calculating the combined margin emission factor:

Calculation of CO_2 emission intensity of the baseline source of electricity is given in Annex 4.

$$BE_{elec,BL,y} = EL_{LFG,y} . EF_{grid,CM,y} \quad \textbf{(3)}$$

$BE_{elec,BL,y}$	Baseline emissions due to the use of grid electricity in year y, (tCO2e)
$EL_{LFG,y}$	net quantity of electricity produced using LFG, which in absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year y, in megawatt hours (MWh)
$EF_{grid,CM,y}$	Build margin CO_2 emission factor in year y (tCO_2/MWh)

Calculation of $CEF_{elec,BL,y}$

Stepwise approach of 'Tool to calculate the emission factor for an electricity system' version 02.2.0 [19] is used to find this combined margin (emission coefficient) as described below:
Step 1: Identify the relevant electricity systems

There are 21 regional distribution regions in Turkey but no regional transmission system is defined. In Article 20 of License Regulation it is stated that '*TEIAS shall be in charge of all transmission activities to be performed over the existing transmission facilities and those to be constructed as well as the activities pertaining to the operation of* ***national transmission system*** *via the National Load Dispatch Center and the regional load dispatch centers connected to this center and the operation of Market Financial Reconciliation Center*[20]'. As it can be understood from this phrase, only one transmission

[19] See, http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v2.pdf
[20] See, http://www.epdk.org.tr/english/regulations/electric/license/licensing.doc (page 21)

system, which is national transmission system is defined and only TEİAŞ is in the charge of all transmission system related activities. Moreover, a communication with representative of TEIAŞ which indicates that: “There are not significant transmission constraints in the national grid system which is preventing dispatch of already connected power plants” is submitted to the DOE. Therefore, the national grid is used as electric power system for project activity. The national grid of Turkey is connected to the electricity systems of neighbouring countries. Complying with the rules of the tool, the emission factor for imports from neighbouring countries is considered 0 (zero) tCO_2/MWh for determining the OM.

There is no information about interconnected transmission capacity investments, as TEİAŞ, who operates the grid, also didn’t take into account imports-exports for electricity capacity projections.[21] Because of that, for BM calculation transmission capacity is not considered.

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)

According to Tool project participants may choose between the following two options to calculate the operating margin and build margin emission factor:

Option I: Only grid power plants are included in the calculation.
Option II: Both grid power plants and off-grid power plants are included

For this project **Option I** is chosen.

Step 3: Select an operating margin (OM) method

The Turkish electricity mix does not comprise nuclear energy. Also there is no obvious indication that coal is used as must run resources. Therefore, the only low cost resources in Turkey, which are considered as must-run, are Hydro, Renewables and Waste, Geothermal and Wind (according to statistics of TEIAS).

Table 10: Share of Low Cost Resource (LCR) Production 2005-2009 (Production in GWh) [22]

	2005	2006	2007	2008	2009
Gross production	161,956.2	176,299.8	191,558.1	198,418.0	194.812,9
TOTAL LCR Production	39,836.3	44,618.7	36,575.6	34,498.6	38.229,6
Hydro	39,560.5	44,244.2	35,850.8	33,269.8	35.958,4
Renewable and Waste	122.4	154.0	213.7	219.9	340,1
Geothermal and Wind	153.4	220.5	511.1	1,008.9	1.931,1
Share of LCRs	*24.60%*	*25.31%*	*19.09%*	*17.39%*	19,62%
Average of last five years	**21.20%**				

[21] See, http://www.epdk.org.tr/yayin_rapor/elektrik/yayin/uretimKapasiteProjeksiyonu2008_2017.pdf (page 39)
[22] See, http://www.teias.gov.tr/istatistik2009/32(75-09).xls

As average share of low cost resources for the last five years is far below 50% (21.20%), the Simple OM method is applicable to calculate the operating margin emission factor ($EF_{grid,OM,y}$)

For the Simple OM method, the emissions factor can be calculated using either of the two following data vintages:

- Ex ante option: A 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, or
- Ex post option: The year, in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring.

The ex ante option is selected for Simple OM method, with the most recent data for the baseline calculation stemming from the years 2007 to 2009.

Step 4: Calculate the operating margin emission factor according to the selected method

The Simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants. The calculation of the Simple OM emission factor can be based on

- data on net electricity generation a CO_2 emission factor of each power unit (Option A), or
- data on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system (option B).

Option B is chosen to calculate the Simple OM, as there is no power plant specific data available, renewable power generation are considered as low-cost power sources and amount of electricity supplied to the grid by these sources is known.

Where Option B is used, the simple OM emission factor is calculated based on the electricity supplied to the grid by all power plants serving the system, not including low-cost / must-run power plants, and based on the fuel type(s) and total fuel consumption of the project electricity system, as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} x NCV_{i,y} x EF_{CO2,i,y}}{EG_y} \quad \textbf{(4)}$$

Where:

$EF_{grid,OMsimple,y}$	Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$FC_{i,y}$	Amount of fossil fuel type i consumed in the project electricity system in year y

	(mass or volume unit)
$NCV_{i,y}$	Net calorific value (of fossil fuel type i in year y (GJ / mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fossil fuel type i in year y (tCO_2/GJ)
EG_y	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / units, in year y (MWh)
i	All fossil fuel types combusted in power sources in the project electricity system in year y
y	three most recent years for which data is available at the time of submission of the PDD to the DOE for validation

For the calculation of the OM the consumption amount and heating values of the fuels for each sources used for the years 2007, 2008 and 2009, is taken from the TEİAŞ annual statistics, which holds data on annual fuel consumption by fuel types as well as electricity generation amounts by sources and electricity imports. All the data needed for the calculation, including the emission factors and net calorific values (NCVs), are provided in Annex 4. Total CO_2 emission due to electricity generation in Turkey for the years of 2007, 2008 and 2009 are given in Table 12.

Table 11:CO2 emissions from electricity production 2007-2009 (ktCO2) [23]

	2007	2008	2009
CO_2-Emmissions	97.649	103.352	97.863

Table 13 presents the gross electricity production data by all the relevant energy sources. Low-cost/must run resources like hydro, wind, geothermal and biomass do not emit CO_2 and thus are not taken into account in calculations.

Tablo 12: Gross electricity production by fossil energy sources 2007-2009 (GWh)

Energy Source	2007	2008	2009
Natural Gas	95.024,8	98.685,3	96.094,7
Lignite	38.294,7	41.858,1	39.089,5
Coal	15.136,2	15.857,5	16.595,6
Fuel Oil	6.469,6	7.208,6	4.439,8
Motor Oil	13,3	266,3	345,8
Naphtha	43,9	43,6	17,6
LPG	0,0	0,0	0,4
Total fossil fuels	**154.982,5**	**163.919,4**	**156.583,4**

[23] For detail calculation see Annex 3

Above table shows gross data, but EG_y in the above described formula means electricity delivered to the grid, i.e. net generation, the following table shall help to derive net data by calculating the net/gross proportion on the basis of overall gross and net production numbers.

Tablo 13: Net/gross electricity production 2006-2009 (GWh) [24]

	2007	2008	2009
Gross Production	191.558,13	198.418,00	194.812,90
Net Production	183.339,70	189.761,90	186.619,30
Relation	**95,71%**	**95,64%**	**95,79%**

Multiplying these overall gross/net relation percentages with the fossil fuels generation amount does in fact mean an approximation. However this is a conservative approximation as the consumption of plant auxiliaries of fossil power plants is higher than for the plants that are not included in the baseline calculation. In the end this would lead to a lower net electricity generation and therefore to a higher OM emission factor and higher emission reductions.

Table 15 shows the resulting net data for fossil fuel generation and adds electricity imports.

Tablo 14:Electricity supplied to the grid, relevant for OM (GWh)

	2007	2008	2009
Net El. Prod. by fossil fuels	148.333,3	156.768,3	149.997,7
Electricity Import	864,3	789,4	812,0
Electricity supplied to grid by relevant sources	**149.197,6**	**157.557,7**	**150.809,7**

Electricity import is added to the domestic supply in order to fulfill the Baseline Methodology requirements. Imports from connected electricity systems located in other countries are weighted with an emission factor of 0 (zero) tCO_2/MWh.

The last step is to calculate $EF_{grid,OMsimple,y}$:

Tablo 15: Calculation of Weighted EFgrid,OMsimple,y (ktCO2/GWh)

	2007	2008	2009
CO_2-Emmissions ($ktCO_2$)	97.649	103.352	97.863
Net Electricity Supplied to Grid by relevant sources (GWh)	149.197,6	157.557,7	150.809,7
EFgrid,OMsimple,y (ktCO2/GWh)	0,6545	0,6560	0,6489
3-year Generation Weighted Average $EF_{grid,OMsimple,y}$ ($ktCO_2/GWh$)	**0.6532**		

Step 5:. Calculate the build margin emission factor

[24] For Net Production See, http://www.teias.gov.tr/istatistik2008/30(84-08).xls (column L)

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, calculated as per formula 13 of the tool:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} x EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \textbf{(5)}$$

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
m	=	Power units included in the build margin
y	=	Most recent historical year for which power generation data is available

Because of only fuel types and electricity generation data are available for the sample group, *Option B2* of Simple OM method is used to calculate emission factor. The formula corresponds to formula 3 of the tool:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} x 3.6}{\eta_{m,y}} \quad \textbf{(6)}$$

Where:

$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (tCO_2/MWh)
$EF_{CO2,m,i,y}$	=	Average CO_2 emission factor of fuel type i used in power unit m in year y (tCO_2/GJ)
$\eta_{m,y}$	=	Average net energy conversion efficiency of power unit m in year y (%)
y	=	Three most recent years for which data is available at the time of submission of the PDD to the DOE for validation

BM emission factor calculation and resulted BM factor is given in the Table 17. For BM factor calculation, since no official emission factors for different fuel types are available, lower confidence default values of IPCC Guidelines are applied.

Tablo 16: BM emission factor calculation as per tool equations 13/3.

Energy Source	Sample Group Total Generation (GWh)	Effective CO_2 emission factor (tCO_2/TJ)	Average Efficiency ($\eta_{m,y}$)	CO_2 Emission ($ktCO_2$)
Natural Gas	20,834.0	54.3	60.00%	6.787,7
Lignite	7,020.0	90.9	38.63%	6.045,3

Coal	1,923.3	89.5	41.50%	1.493,3
Fuel Oil	2,262.3	72.6	46.00%	1.285,4
Hydro	6,168.9	0.0	0.00%	0,0
Renewables	788.5	0.0	0.00%	0,0
Total	38,996.95			15.611,7
$EF_{grid,BM,y}$ (tCO_2/MWh)	**0.4003**			

<u>Step 6:</u> *Calculate the combined margin (CM) emission factor*

The combined margin emission factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM} \quad \textbf{(7)}$$

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year y (tCO_2/MWh)
w_{OM}	=	Weighting of operating margin emissions factor (%)
w_{BM}	=	Weighting of build margin emissions factor (%)

According to the Tool for biogas power generation project activities: w_{OM} = 0.5 and w_{BM} = 0.5 will be applied

Then:

$EF_{grid,CM,y}$ = 0.6532 tCO_2/MWh * 0.5 + 0.4003 tCO_2/MWh * 0.5 = 0.5267 tCO_2/MWh

B. Ex-post emission reductions

The actual emission reduction achieved by the project during the crediting period will be calculated using the amount of methane recovered and destroyed/gainfully used by the project activity, calculated as:

$$ER_{calculated,y} = (MD_y - MD_{reg,y}) * GWP_{CH4} + BE_{elec,BL,ye} \quad \textbf{(8)}$$

Where:

MD_y Methane captured and destroyed/gainfully used by the project activity in the year y (tCH4)

Determination of MD_y

The methane destroyed by the project activity (MD_y) during a year is determined by ex post monitoring the quantity of methane actually flared and gas used to generate electricity, as well as the monitoring the quantity the total quantity of methane captured, the comparison will be taken between those two quantity, and the lower one shall be adopted, i.e.
The project will capture only a fraction of the whole LFG due to following reasons:

- The degassing system has its own efficiency
- The enclosed flares have their destruction efficiency

The following procedure applies when the total quantity of methane captured is the highest. The working hours of the energy plant will be monitored and no emission reduction will be claimed for methane destruction in the energy plant during non-operational hours.

$$MD_y = \sum_i LFG_{i,y} * w_{CH4,Y} * D_{CH4,Y} \qquad \textbf{(9)}$$

where

$LFG_{i,y}$	Landfill gas destroyed via method i (flaring, fuelling, combustion, injection in a grid, etc.) in the year y (m^3LFG)
$w_{CH4,y}$	the average methane fraction of the landfill gas measured during the year and expressed as a fraction [$m^3 CH_4/m^3$ LFG]
$D_{CH4,y}$	methane density [t $CH_4/m^3 CH_4$]

Project emissions

Project activity emissions consist of
(a) CO2 emissions from use of fossil fuel or electricity related to the power used by the project activity facilities ($PE_{power,y}$);
(b) Emissions from flaring or combustion of the gas stream ($PE_{flare,y}$);
(c) Emissions from the landfill gas upgrading process ($PE_{process,y}$), where applicable.

Equation 1:

$$PE_y = PE_{power,y} + PE_{process,y} + PE_{flare,y} \qquad \textbf{(10)}$$

Where;

PE_y	Project emissions in year y (tCO2e)
$PE_{power,y}$	Emissions from electricity in the project case.
$PE_{process,y}$	Emissions from the landfill gas upgrading process in the year y (tCO2e), determined by following the relevant procedures described in Annex 1 of AMS-III.H
$PE_{flare,y}$	Emissions due to flaring of LFG

Project emissions from electricity consumption are determined as per the procedures described in AMS-I.D 'Grid connected renewable electricity generation'. For project emissions from fossil fuel consumption the emission factor for the fossil fuel shall be used (tCO2/tonne). If recovered landfill gas is used to power auxiliary equipment of the project it should be taken into account accordingly, using zero as its emission factor. In the project design stage, no electricity is assumed to be imported from the grid, and this parameter will be monitored and be deducted when calculate the net electricity generation during the crediting period if any. While it is assumed that the project does not involve emissions from consumption of electricity in the project case (LFG is used for on-site electricity generation), thus $PE_{power,y}$ equals zero.

The project does not involve in the landfill upgrading process, thus $PE_{process,y}$ is zero.

In case flaring (single or multiple) is used to destroy all or part of the recovered landfill gas, project emissions from flaring in year y ($PE_{flare,y}$ in tCO2e) will be determined following the procedure described in the 'Tool to determine project emissions from flaring gases containing methane' for each flare respectively. In the stage of estimation of project emissions, it is assumed that there will be no project emission due to flaring while project technology enables destruction of methane by electricity generation. However, during monitoring and based on the monitored data of flaring, if happens, project emission from flaring will be calculated and deducted from actual baseline emissions.

Application of "Tool to determine project emissions from flaring gases containing Methane"

According to "Tool to determine project emissions from flaring gases containing Methane", the project emissions from flaring of the residual gas stream $PE_{flare,y}$ are determined considering the following steps:

STEP 1: Determination of the mass flow rate of the residual gas that is flared
STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas
STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis
STEP 4: Determination of methane mass flow rate of the exhaust gas on a dry basis
STEP 5: Determination of methane mass flow rate of the residual gas on a dry basis
STEP 6: Determination of the hourly flare efficiency
STEP 7: Calculation of annual project emissions from flaring based on measured hourly values or based on default flare efficiency.

The calculation procedure in this tool determines the flow rate of methane before and after the destruction in the flare, taking into account the amount of air supplied to the combustion reaction and the exhaust gas composition (oxygen and methane).

The project activity applies an enclosed flare. The temperature in the exhaust gas of the flare is measured to determine whether the flare is operating or not. For enclosed flares, either of the following two options can be used to determine the flare efficiency:

(a) To use a 90% default value. Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour.

(b) Continuous monitoring of the methane destruction efficiency of the flare (flare efficiency).

Option (a) is chosen for the methane destruction efficiency of the flare. If there is no record of the temperature of the flare or if the recorded temperature is less than 500 °C for any particular hour, it shall be assumed that during that hour the flare efficiency is zero.

Project emissions are determined by multiplying the methane flow rate in the residual gas with the flare efficiency for each hour of the year.

STEP 1. Determination of the mass flow rate of the residual gas that is flared

This step calculates the residual gas mass flow rate in each hour h, based on the volumetric flow rate and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

The calculation follows the procedure as described by the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". Option A is applied: Same basis (dry basis) is considered for the measurement of the volumetric flow rate of the residual gas and the measurement of the volumetric fraction of methane in the residual gas (see B.7.1).

$$FM_{RG,h} = \rho_{RG,n,h} \times FV_{RG,h} \qquad \textbf{(11)}$$

where:

$FM_{RG,h}$ mass flow rate of the residual gas in hour h [kg/h]
$\rho_{RG,n,h}$ density of the residual gas at normal conditions in hour h [kg/m^3]
$FV_{RG,h}$ volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h [m^3/h]
and:

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} \times T_n} \qquad \textbf{(12)}$$

where:

$\rho_{RG,n,h}$	density of the residual gas at normal conditions in hour h [kg/m^3]
P_n	atmospheric pressure at normal conditions (101,325) [Pa]
R_u	universal ideal gas constant (8,314) [Pa.m^3/kmol.K]
$MM_{RG,h}$	molecular mass of the residual gas in hour h [kg/kmol]
T_n	temperature at normal conditions (273.15)[K]

and:

$$MM_{RG,h} = \sum\left(fv_{i,h} \cdot MM_i\right) \quad \textbf{(14)}$$

where:

$MM_{RG,h}$	molecular mass of the residual gas in hour h [kg/kmol]
$fv_{i,h}$	volumetric fraction of methane in the residual gas in the hour h [-]
MM_i	molecular mass of residual gas components i [kg/kmol]
i	the components: CH_4 and N_2

A simplified approach is used, where only the volumetric fraction of methane is measured and it is considered the difference to 100% as being nitrogen (N_2).

STEP 2. Determination of the mass fraction of carbon, hydrogen and nitrogen in the residual gas[25]

Determination of mass fractions of carbon, hydrogen and nitrogen in the residual gas, calculated from the volumetric fraction of each component i in the residual gas are as follows:

$$fm_{j,h} = \frac{\sum_i fv_{i,h} \cdot AM_j \cdot NA_{j,i}}{MM_{RG,h}} \quad \textbf{(15)}$$

where:

$fm_{j,h}$	mass fraction of element j in the residual gas in hour h [-]
$fv_{i,h}$	volumetric fraction of component i in the residual gas in the hour h
AM_j	atomic mass of element j [kg/kmol]

[25] As the simplified approach is applied and only methane volumetric fraction is measured, where pure nitrogen is considered as the rest of the residual gas, the mass fractions of carbon, hydrogen and nitrogen are determined (oxygen is excluded).

$NA_{j,i}$	number of atoms of element j in component i [-]
$MM_{RG,h}$	molecular mass of the residual gas in hour h [kg/kmol]
j	the elements carbon, hydrogen and nitrogen
i	the components: CH_4 and N_2

Step 3 and 4 are only applicable in case of enclosed flares and continuous monitoring of the flare efficiency, which is the project activity. While default value is applied, step 3 and 4 is skiped.

STEP 5. Determination of methane mass flow rate in the residual gas on a dry basis

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,,n,h}$) in the same reference conditions (normal conditions and dry or wet basis).

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n} \qquad \textbf{(16)}$$

where:

$TM_{RG,h}$	mass flow rate of methane in the residual gas in the hour h [kg/h]
$FV_{RG,h}$	volumetric flow rate of the residual gas in dry basis at normal conditions in hour h [m^3/h]
$fv_{CH4,RG,h}$	volumetric fraction of methane in the residual gas on dry basis in hour h (NB: this corresponds to $fv_{i,RG,h}$ where i refers to methane).
$\rho_{CH4,n,h}$	density of methane at normal conditions (0.716) [kg/m^3]

STEP 6. Determination of the hourly flare efficiency

The determination of the hourly flare efficiency depends on the operation of flare (e.g. temperature), the type of flare used (open or enclosed) and, in case of enclosed flares, the approach selected by project participants to determine the flare efficiency (default value or continuous monitoring).

In the case of Afyonkarahisar Landfill Project, an enclosed flare is used and the flare efficiency is determined by continuous monitoring. Therefore, the flare efficiency in the hour h ($\eta_{flare,h}$) is

- 0 % if the temperature of the exhaust gas of the flare (T_{flare}) is below 500 °C during more than 20 minutes during the hour h
- determined as per the following equation in cases where the temperature of the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h:

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}} \quad \textbf{(17)}$$

where:

$TM_{FG,h}$ mass flow rate of methane in exhaust gas averaged in a period of time t (hour, two months or year) [kg/h]

$TM_{RG,h}$ mass flow rate of methane in the residual gas in the hour h [kg/h]

STEP 7. Calculation of annual project emissions from flaring

Project emission from flaring are calculated as the sum of emission from each hour h, based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour h ($\eta_{flare,h}$), as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH4}}{1000} \quad \textbf{(18)}$$

Leakage

No leakage effects need to be accounted under the approved consolidated methodology AMS-III.G

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

Data and Parameters not Monitored

Data / Parameter:	GWP_{CH4}
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential of CH4
Source of data:	IPCC
Data Applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	21 of the first commitment period. Shall be updated according to any future COP/MOP decisions
Any comment:	

Data / Parameter:	D_{CH4}

Data unit:	tCH_4/ m^3tCH_4
Description:	Methane Density
Source of data:	
Data Applied	
Justification of the choice of data or description of measurement methods and procedures actually applied :	At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4/ m^3tCH_4
Any comment:	

Data / Parameter:	BE_{CH4},SWDS,y
Data unit:	tCO_2e
Description:	Methane generation from the landfill in the absence of the project activity at year *y*
Source of data:	Calculated as per the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"
Data Applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"
Any comment:	Used for *ex ante* estimation of the amount of methane that would have been destroyed/ combusted during the year

Data / Parameter:	MD_{Hist}
Data unit:	tCH_4
Description:	Amount of methane destroyed historically for the previous year before the start of project activity.
Source of data:	Project proponent
Data Applied	
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	This parameter could be used for the estimation of AF

Data / Parameter:	MG_{Hist}
Data unit:	tCH_4

Description:	Amount of methane generated historically for the previous year before the start of project activity
Source of data:	Project proponent
Data Applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	Estimated using the actual amount of waste disposed in the landfill as per the latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"
Any comment:	This parameter could be used for the estimation of AF

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

The following data and parameters are used. These parameters are not required to be monitored but only used for projection of avoided methane emissions.

Data / Parameter:	**φ**
Data unit:	-
Description:	Model correction factor to account for model uncertainties
Source of Data	"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (Version 06)
Value to be applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	Oonk et el. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results.
Any comment:	

Data / Parameter:	**OX**
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 5 Waste, Table 3.2.
Value to be applied:	0.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	

Any comment:	-

Data / Parameter:	**F**
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 5 Waste,
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	Based on the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”. This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.
Any comment:	

Data / Parameter:	**DOC_f**
Data unit:	-
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 5 Waste,
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	-

Data / Parameter:	**MCF**
Data unit:	-
Description:	Methane correction factor
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 5 Waste, Table 3.1
Value applied:	1.0
Justification of the choice of data or description of measurement methods and procedures actually applied :	The methane correction factor (MCF) accounts for the fact that managed SWDS produces more methane than unmanaged SWDS. Based on the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”, IPPC default value for anaerobic managed SWDS is applied.
Any comment:	

Data / Parameter:	**DOC_j**

Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type j
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 5 Waste, Tables 2.4 and 2.5.
Value applied:	(see table below)
Justification of the choice of data or description of measurement methods and procedures actually applied :	MAP/PET < 1 for province of Afyonkarahisar, thus dry values are used in accordance to "the tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" version 6 and 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 5 Waste, Tables 2.4 and 2.5.
Any comment:	0.40 (kitchen waste), 0.03 (paper & carton), 0.08 (textiles), 0.03 (wood), 0.10 (garden/fruits), 0.36 (glass, plastic, metal, other inert waste)

Value applied:

Waste type j	DOC_j (% wet waste)	DOC_j (% dry waste)
Wood and wood products	43	50
Pulp, paper and cardboard (other than sludge)	40	44
Food, food waste, bevarages and tobacco (other than sludge)	15	38
Textiles	24	30
Garden, yard and park waste	20	49
Glass, plastic, metal, other inert waste	0	0

Data / Parameter:	**k_j**
Data unit:	-
Description:	Decay rate for the waste type j
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 5 Waste, Table 3.3.
Value applied:	0.03 (paper & carton), 0.08 (textiles), 0.03 (wood), 0.10 (garden & park wastes), 0.15 (food)

Waste type j		**Boreal and Temperate (MAT ≤ 20 °C)**		**Tropical (MAT ≥ 20 °C)**	
		Dry MAP/PET < 1)	Wet (MAP/PET > 1)	Dry (MAP < 1000 mm)	Wet (MAP > 1000)
Slowly Degrading	Pulp, paper, cardboard (other than sludge, textiles)	0.04	0.06	0.045	0.07

	Wood, wood products and straw	.02	0.03	0.025	0 035
Moderately Degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.10	0.065	0.17
Rapidly Degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	0.40

Any comment:	Medium Average temperature MAT [°C]: 10.5 Medium Average Precipitation MAP [kg/m^2]: 33 Source: http://www.dmi.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx?m=AFYON

Data / Parameter:	**Gross electricity generation**
Data unit:	**MWh**
Description:	Gross Electricity supplied to the grid by relevant sources (2007-2009)
Source of data used:	Turkish Electricity Transmission Company (TEIAS), Annual Development of Turkey's Gross Electricity Generation of Primary Energy Resources (1975-2009) TEIAS, see: http://www.teias.gov.tr/istatistik2009/32(75-09).xls
Value applied:	See table 14 and table 15
Justification of the choice of data or description of measurement methods and procedures actually applied :	TEIAS is the national electricity transmission company, which makes available the official data of all power plants in Turkey.
Any comment:	

Data / Parameter:	**Net electricity generation**
Data unit:	**MWh**
Description:	Net electricity fed into the grid. Used for the calculation of the net/gross relation (Including Import and Export figures)
Source of data used:	Turkish Electricity Transmission Company (TEIAS), Annual Development of Electricity Generation-Consumption and Losses in Turkey (1984-2009) TEIAS,

	See http://www.teias.gov.tr/istatistik2009/30(84-09).xls
Value applied:	See table 15
Justification of the choice of data or description of measurement methods and procedures actually applied :	This data is used to find relation between the gross and net electricity delivered to the grid by fossil fuel fired power plants (Table 14). Import and Export data is used to find total net electricity fed into the grid in the years of 2007, 2008 and 2009 (table 15) TEIAS is the national electricity transmission company, which makes available the official data of all power plants in Turkey.
Any comment:	

Data / Parameter:	**$HV_{i,y}$**
Data unit:	Mass or volume unit
Description:	Heating Values of fuels consumed for electricity generation in the years of 2006, 2007, 2008 and 2009
Source of data used:	Heating Values Of Fuels Consumed In Thermal Power Plants In Turkey By The Electric Utilities, TEİAŞ. See: http://www.teias.gov.tr/istatistik2009/46.xls
Value applied:	See table 22
Justification of the choice of data or description of measurement methods and procedures actually applied :	TEİAŞ is the national electricity transmission company, which makes available the official data of all power plants in Turkey. There is no national NVC data in Turkey. However, TEİAŞ announces Heating values of fuels. This data is used to calculate annual NCVs for each fuel type.
Any comment:	

Data / Parameter:	**$FC_{i,y}$**
Data unit:	Mass or volume unit
Description:	Fuels consumed for electricity generation in the years of 2007, 2008 and 2009
Source of data used:	Annual Development of Fuels Consumed In Thermal Power Plants In Turkey By The Electric Utilities, TEİAŞ. See: http://www.teias.gov.tr/ist2007/43.xls
Value applied:	See table 23
Justification of the choice of data or description of measurement methods and procedures actually applied :	TEİAŞ is the national electricity transmission company, which makes available the official data of all power plants in Turkey.
Any comment:	

Data / Parameter:	**$NCV_{i,y}$**

Data unit:	TJ/kton, TJ/million m^3
Description:	Net Calorific Value of fuel types in the years of 2006, 2007 and 2008
Source of data used:	Calculated by using HVi,y to FCi,y as Net Calorific Values of fuel types are not directly available in Turkey.
Value applied:	See table 24
Justification of the choice of data or description of measurement methods and procedures actually applied :	TEİAŞ is the national electricity transmission company, which makes available the official data of power plants in Turkey. Calculation of NCVs from national $HV_{i,y}$ and $FC_{i,y}$ data, **Hata! Başvuru kaynağı bulunamadı.** and **Hata! Başvuru kaynağı bulunamadı.**, is preferred to default IPCC data as these are more reliable.
Any comment:	

Data / Parameter:	**Sample Group for BM emission factor**
Data unit:	Name of the plants, MW capacities, fuel types, annual electricity generations and dates of commissioning.
Description:	Most recent power plants which compromise 20% of total generation
Source of data used:	Annual Development of Fuels Consumed in Thermal Power Plants in Turkey by the Electric Utilities, TEIAS: For plants in 2004: http://www.teias.gov.tr/istat2004/7.xls For plants in 2005: http://www.teias.gov.tr/istatistik2005/7.xls For plants in 2006: http://www.epdk.org.tr/yayin_rapor/elektrik/yayin/uretimKapasiteProjeksiyonu.pdf (page 76 and 77 for installed power of new plants, page 67-75 for generation amounts. For capacity additions, interpolation method is used for generation amounts) For plants in 2007: http://www.epdk.org.tr/yayin_rapor/elektrik/yayin/uretimKapasiteProjeksiyonu2008_2017.pdf (page 121 and 122 for installed power of new plants, page 111-120 for generation amounts. For capacity additions, interpolation method is used for generation amounts) For plants in 2008: http://www.teias.gov.tr/projeksiyon/KAPASITEPROJEKSIYONU2009.pdf (page 95 for plants and pages 82-94 for generation amounts. For capacity additions, interpolation method is used for generation amounts)
Value applied:	See table 26
Justification of the choice of data or description of measurement methods and procedures actually applied :	TEIAS is the national electricity transmission company, which makes available the official data of all power plants in Turkey.
Any comment:	

Data / Parameter:	$\mathbf{EF_i}$
Data unit:	tCO_2/GJ
Description:	Emission factor for fuel type *I*

Source of data used:	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the IPCC Guidelines on National GHG Inventories. http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf
Value applied:	See table 24
Justification of the choice of data or description of measurement methods and procedures actually applied :	No plant specific and national emission factor data is available in Turkey. So, IPCC default data is used. For Fuel Oil Power Plants: 'Gas/Diesel Oil' data is used for conservativeness. For Coal Power Plants: In the 205th page of official document given in the link below, it is stated that Çolakoğlu and İçdaş utilizes 'Taşkömürü' (Hardcoal). And at the Table-2 in page 157 of the same document, Taşkömürü is dived in two groups: Bituminous and Antharcite. Since Sub-Bituminous Coal is under Brown Coal in the same table and since Other Bituminous Coal has lower EF than Anthracite in 1.4 of IPCC Guidelines, EF for 'Other Bituminous Coal' is used. See: http://www.dpt.gov.tr/DocObjects/Icerik/4225/Enerji_Hammaddeleri_(Linyit_Taskömuru-Jeotermal)
Any comment:	

Data / Parameter:	$\eta_{i,y}$
Data unit:	-
Description:	Average energy conversion efficiency of power unit m in year y
Source of data used:	TEİAŞ and Annex I of the “Tool to calculate the emission factor for an electricity system”
Value applied:	See Table 17
Justification of the choice of data or description of measurement methods and procedures actually applied :	For Lignite and Coal power plants, plants specific values are applied. There are two lignite power plant in Sample Group. These are Çan and Elbistan PPs. For efficiency factor of Çan PP is taken form presentation of Mr. Sefer Bütün (General Manager of EUAS, state production company), which is ‘Thermal Power Plants and Environment’. This presentation is submitted to DOE. In the page 18 of the presentation, it is stated that for pulverized lignite power plants the highest achieved electrical efficiency rate is 38%. So this rate is applied also for Elbistan-B PP. Weighted average of these efficiency rates, which turns to be 38.63% is used for lignite power plants. For coal power plants, the highest efficiency rate for ‘fluidized bed’ technology which is 41.5% for PFBS is applied as coal PPs in the sample group (Çolakoğlu (Capacity Increment) and Çan Gr I-II) are utilizing fluidized bed type technology. For reference see: http://www.mimag-samko.com.tr/akiskan_yatakli_kazanlar.pdf (last paragraph of page 6)

	For Natural Gas and Oil plants efficiencies, default value given in the tool is applied: http://cdm.unfccc.int/methodologies/Tools/EB35_repan12_Tool_grid_emission.pdf
Any comment:	

In addition the following constants - as provided in the "Tool to determine project emissions from flaring gases containing methane" (EB 28, Meeting report Annex 13, page 11/12) - are used in the equations 5-19.

Tablo 17: Constants and default values used in equations to determine project emissions from flaring gases

Parameter	Unit	Description	Value
MM_{CH4}	kg/kmol	Molecular mass of methane	16.04
MM_{CO}	kg/kmol	Molecular mass of carbon monoxide	28.01
MM_{CO2}	kg/kmol	Molecular mass of carbon dioxide	44.01
MM_{O2}	kg/kmol	Molecular mass of oxygen	32.00
MM_{H2}	kg/kmol	Molecular mass of hydrogen	2.02
MM_{N2}	kg/kmol	Molecular mass of nitrogen	28.02
AM_c	kg/kmol (g/mol)	Atomic mass of carbon	12.00
AM_h	kg/kmol (g/mol)	Atomic mass of hydrogen	1.01
AM_o	kg/kmol (g/mol)	Atomic mass of oxygen	16.00
AM_n	kg/kmol (g/mol)	Atomic mass of nitrogen	14.01
P_n	Pa	Atmospheric pressure at normal conditions	101,325
R_u	$Pa.m^3/kmol.K$	Universal ideal gas constant	8,314.472
T_n	K	Temperature at normal conditions	273.15
MF_{O2}	Dimensionless	O_2 volumetric fraction of air	0.21
GWP_{CH4}	$t\ CO_2/t\ CH_4$	Global warming potential of methane	21
MV_n	$m^3/kmol$	Volume of one mole of any ideal gas at normal temperature and pressure	22.414
$\rho_{CH4,n}$	kg/m^3	Density of methane gas at normal conditions	0.716
$NA_{i,j}$	Dimensionless	Number of atoms of element j in component i, depending on molecular structure	

B.6.3 Ex-ante calculation of emission reductions:

The emission reduction achieved by the project activity can be estimated ex ante in the PDD by Methodology AMS-III.G and AMS-I.D

$$ER_{estimated,y} = BE_y - PE_y - LE_y \quad \textbf{(19)}$$

Ex-ante calculation of emission reductions from waste management:

For the *ex-ante* calculation of the amount of methane that would have been destroyed/ combusted during year *y*, it is assumed that only a percentage of gas generated on site can be captured and collected by the proposed project. In the project activity of Afyonkarahisar Landfill, the waste disposal site started 2009 and according to the feasibility study of the project degassing efficiency is 60 %. Thus;

$$MD_{project,y} = BE_{CH4;SWDS,y} * 60\% \quad \textbf{(20)}$$

where

$MD_{project,y}$	the amount of methane that would have been destroyed /combusted during the year, in tonnes of methane
$BE_{CH4,SWDS,y}$	Methane generation from the landfill in the absence of the project activity at year y (t CO_2e)
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period is 21 t CO_2/t CH_4

The amount of methane that would in the absence of the project activity be generated from disposal of waste at the landfill site ($BE_{CH4,SWDS,y}$) is calculated with a multi-phase model. The calculation is based on a first order decay, FOD model. The model differentiates between the different types of waste j with respectively different decay rates k_j and different fractions of degradable organic carbon (DOC_j). The model calculates the methane generation based on the waste streams $W_{j,x}$ disposed in each year x, where x runs from the first year of landfill operation x=1 to the year for which emissions are calculated (x=y

The ex-ante estimation of the amount of methane destroyed by the project activity $MD_{project,y}$ is based on the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (version 06.0.0, EB 65, Report Annex 19):

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j(y-x)} \cdot \left(1-e^{-k_j}\right) \qquad \textbf{(21)}$$

where

φ	model correction factor to account for model uncertainties (0.9)
f	fraction of methane captured at SWDS and flared, combusted or used in another manner (default value as per ACM 0001 is zero)
OX	oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or another material covering waste)
F	fraction of methane in the SWDS gas (volume fraction (0.5))
DOC_f	fraction of degradable organic carbon (DOC) that can decompose
MCF	methane correction factor
$W_{j,x}$	amount of organic waste type j prevented from disposal in the SWDS in the year x [t]
DOC_j	fraction of degradable organic carbon (by weight) in the waste type j
k_j	decay rate for waste type j
j	waste type category (index)
x	year of receiving wastes at the landfill site: x runs from the first year of landfill operation x=1 to the year for which avoided emissions are calculated (x = y)
y	year for which methane emissions are calculated

Based on the above equations the amount of methane destroyed by the project activity $MD_{project,y}$ is calculated. The values applied for each parameter are listed in B.6.1. as the data available at validation.

Table 18: Ex-ante calculation of emission reductions from waste management

Years	Disposed MSW [t/a]	Methane generation potential BE CH4,SWDS,y [CO_2e]	Estimation of avoided GHG during the crediting period BEy [t CO_2e]	Project emissions from flaring PEy [t CO2e]	Emission reductions ER [t CO2e]
(March-December)2012	31.770	17.772	8.886	0	13.100
2013	128.845	25.428	15.257	0	20.314
2014	136.875	32.828	19.697	0	24.754
2015	139.613	39.992	23.995	0	29.052
2016	142.405	46.934	28.161	0	33.218
2017	145.253	53.674	32.204	0	37.261
2018	148.158	60.142	36.085	0	41.142
(January-March 2019)		66.521	6.652	0	7.495
Total	**872.919**	**343.291**	**170.937**	**0**	**206.336**
Ave p.a.	**87.292**	**49.042**	**24.420**	**0**	**29.477**

* Efficiency of degassing system is considered as 25 per cent for old part of waste disposal site and 60 per cent for new part of disposal site[26].

[26] Feasibility study, page:7,15

For detailed information see the document Afyonkarahisar_Calculation_Tool.xls.

Ex-ante estimation of emission reductions from electricity production

Based on the methodology AMS-I.D and the 'Tool to calculate the emission factor for an electricity system' version 02.2.0, emission factor of the grid determined as:

$EF_{grid,CM,y}$ = **0.5267 tCO_2/MWh**

When applying the formula below, the result of emission reduction due to electricity generation is provide in the below table.

$$BE_{elec,BL,y} = EL_{LFG,y}.EF_{grid,CM,y}$$

Tablo 19: Emission reductions from electricity production*

Baseline Emission of the Grid which will be subsituted by Landfill Project				
Years	Capacith Of the electric engine (MWe)	Number of Working Hours	Electricty to be generated (MWh)	Baseli Emissions
Mar-Dec 2012	1,2	6.667	8.000	4.214
2012	1,2	8.000	9.600	5.056
2013	1,2	8.000	9.600	5.056
2014	1,2	8.000	9.600	5.056
2015	1,2	8.000	9.600	5.056
2016	1,2	8.000	9.600	5.056
2017	1,2	8.000	9.600	5.056
2018	1,2	8.000	9.600	5.056
(Jan-Mar)2019	1,2	1.333	1.600	843
Total			**76.800**	**40.451**

*Please refer to the CM_Calculation_Afyonkarahisar Landill file for detailed calculation.

Ex-ante estimation of project emission from flaring of LFG

Operation of flare station: it is assumed that he flare station would operate 100% of the year, project emissions from flaring of the biogas are estimated to be zero, as a high efficiency flare is used and no significant methane contents in the exhaust gas of the flare are expected.

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

Table 20: Emission reductions

Years	Methane generation potential BE CH4,SWDS,y [CO_2e]	Estimation of avoided GHG during the crediting period BEy [t CO_2e]	Project emissions from flaring PEy [t CO2e]	Emission reductions from electricity generation	Emission reductions ER [t CO2e]
(Mar-Dec)2012	17.772	8.886	0	4.214	13.100
2013	25.428	15.257	0	5.057	20.314
2014	32.828	19.697	0	5.057	24.754
2015	39.992	23.995	0	5.057	29.052
2016	46.934	28.161	0	5.057	33.218
2017	53.674	32.204	0	5.057	37.261
2018	60.142	36.085	0	5.057	41.142
(Jan-Mar 2019)	66.521	6.652	0	843	7.495
Total	**343.291**	**170.937**	**0**	**35.399**	**206.336**
Ave p.a.	**49.042**	**24.420**	**0**	**5.057**	**29.477**

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

B.7.1 Data and parameters monitored:

Data / Parameter:	**$LFG_{total,y}$**
Data unit:	m^3
Description:	Total amount of landfill gas captured at Normal Temperature and Pressure
Source of data:	Continuous measurement by flow meter by Arel Enerji
Measurement procedures (if any):	Measured by a flow meter. Data will be aggregated monthly and yearly.
Monitoring frequency:	Continuous (average value in a time interval not greater than an hour will be used in the calculations of emission reductions) - Measured by a flow meter, which is a turbine system, with a special internal shell for biogas, completed with a volume checker and a fiscal converter of frequency. Meter

	will provide a minimum accuracy of +/- 1% by volume. All the data will be aggregated hourly, daily, monthly and yearly.
QA/QC procedures:	Flow meters are subject to regular maintenance and testing regime to ensure accuracy. They will be periodically calibrated according to the manufacturer's recommendation. Periodical efficiency control is suggested every 2 years.
Any comment:	Temperature and pressure will be automatically measured and LFG volumes will be expressed in normalised cubic meters.

Data / Parameter:	**$LFG_{flare,y}$**
Data unit:	m^3
Description:	Amount of landfill gas flared at normal temperature and pressure
Source of data:	Continuous measurement by flow meter by Arel Enerji
Measurement procedures (if any):	Measured by a flow meter. Data to be aggregated monthly and yearly for each flare.
Monitoring frequency:	Continuous (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions) Measured by a flow meter, which is a turbine system, with a special internal shell for biogas, completed with a volume checker and a fiscal converter of frequency. Meter will provide a minimum accuracy of +/- 1% by volume. All the data will be aggregated hourly, daily, monthly and yearly.
QA/QC procedures:	Flow meters are subject to regular maintenance and testing regime to ensure accuracy. They will be periodically calibrated according to the manufacturer's recommendation. Periodical efficiency control is suggested every 2 years.
Any comment:	Temperature and pressure will be automatically measured and LFG volumes will be expressed in normalised cubic meters.

Data / Parameter:	**$LFG_{electricity,y}$**
Data unit:	m^3
Description:	Amount of landfill gas combusted in gas engine at normal temperature and pressure

Source of data:	Continuous measurement by flow meter by Arel Enerji
Measurement procedures (if any):	Measured by a flow meter. Data to be aggregated monthly and yearly for each power plant.
Monitoring frequency:	Continuous (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions) Measured by a flow meter, which is a turbine system, with a special internal shell for biogas, completed with a volume checker and a fiscal converter of frequency. Meter will provide a minimum accuracy of +/- 1% by volume. All the data will be aggregated hourly, daily, monthly and yearly.
QA/QC procedures:	Flow meters are subject to regular maintenance and testing regime to ensure accuracy. They will be periodically calibrated according to the manufacturer's recommendation. Periodical efficiency control is suggested every 2 years.
Any comment:	Temperature and pressure will be automatically measured and LFG volumes will be expressed in normalised cubic meters.

Data / Parameter:	$PE_{flare,y}$
Data unit:	t CO_2e
Description:	Project emissions from flaring of the residual gas stream in year y
Source of data:	Calculated as per the "Tool to determine project emissions from flaring gases containing methane" (EB 28, Report Annex 13)
Measurement procedures (if any):	0. Project emissions from flaring of the biogas are estimated to be zero, as a high efficiency flare is used and no significant methane contents in the exhaust gas of the flare are expected.
Monitoring frequency:	Calculated as per the "Tool to determine project emissions from flaring gases containing methane" (EB 28, Report Annex 13)
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$w_{CH4,y}$ (= $fv_{CH4,h}$)

Data unit:	m^3 CH_4/m^3 LFG
Description:	Methane fraction in the landfill gas
Source of data:	Measurements by Arel Enerji using an infrared gas analyser. The data is measured on continuous basis.
Measurement procedures (if any):	n.a. (The ex-ante estimation of the amount of methane destroyed by the project activity $MD_{project,y}$ is based on the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” (version 04, EB 41, Report Annex 10)
Monitoring frequency:	Concentration of methane is controlled by a sample line installed in the main collection system piping. It will be measured on a dry basis but converted to wet basis in case the temperature of the landfill gas exceeds 60 °C. An infrared analyser is to be used of infrared scale of 0-100% for methane. Equipment will provide an accuracy of +/- 1% by volume.
QA/QC procedures:	Analysers are periodically calibrated according to the manufacturer’s recommendation. A zero check and a typical value check are performed by comparison with a standard gas.
Any comment:	-

Data / Parameter:	EL_{LFG}
Data unit:	MWh
Description:	Net amount of electricity generated using LFG
Source of data:	Project participants
Measurement procedures (if any):	Electricity meter
Monitoring frequency:	Continuous
QA/QC procedures:	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy
Any comment:	Required to estimate the emission reductions from electricity generation from LFG, if credits are claimed

Data / Parameter:	$\mathbf{fv_{i,h}}$
Data unit:	-
Description:	Volumetric fraction of component i in the residual gas (landfill gas) in the hour h, where i = CH_4 and N_2
Source of data:	Continuous measurement by Arel Enerji. Values will be averaged on hourly time interval.

Measurement procedures (if any):	Since no PE_{flare} from flaring are expected, the values are not used in the calculation
Monitoring frequency:	Fraction of methane is controlled by a sample line installed in the main collection system piping. It will be measured on a dry basis but converted to wet basis in case the temperature of the landfill gas exceeds 60 °C. An infrared analyser is to be used of infrared scale of 0-100% for methane. Equipment will provide an accuracy of +/- 1% by volume
QA/QC procedures:	Analysers are periodically calibrated according to the manufacturer's recommendation. :A zero check and a typical value check are performed by comparison with a standard gas.
Any comment:	A simplified approach is applied – only methane content of the landfill gas is measured. The remaining part is considered to be N_2.

Data / Parameter:	**$FV_{RG,h}$ (= LFG flare)**
Data unit:	m^3
Description:	Volumetric flow rate of the residual gas at normal conditions in the hour h (=Amount of landfill gas flared at normal temperature and pressure)
Source of data:	Measurements by Arel Enerji using flow meter
Measurement procedures (if any):	n.a. (The ex-ante estimation of the amount of methane destroyed by the project activity $MD_{project,y}$ is based on the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (version 04, EB 41, Report Annex 10)
Monitoring frequency:	Measured by a flow meter, which is a turbine system, with a special internal shell for biogas, completed with a volume checker and a fiscal converter of frequency. Meter will provide a minimum accuracy of +/- 1% by volume. All the data will be aggregated hourly, daily, monthly and yearly. Same basis (wet) is considered for this measurement and the measurement of the volumetric fraction of CH_4 in the residual gas ($fv_{i,h}$), however the sample temperature of residual gas does not exceed 60ºC.
QA/QC procedures:	Flow meters are subject to regular maintenance and testing

	regime to ensure accuracy. They will be periodically calibrated according to the manufacturer's recommendation. Periodical efficiency control is suggested every 2 years.
Any comment:	-

Data / Parameter:	$\mathbf{t_{O2,h}}$
Data unit:	-
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour h
Source of data:	Measurements by Arel Enerji using a continuous infrared gas analyser.
Measurement procedures (if any):	n.a. (The ex-ante estimation of the amount of methane destroyed by the project activity $MD_{project,y}$ is based on the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (version 04, EB 419, Report Annex 10)
Monitoring frequency:	Extractive sampling analysers with water and particulates removal devices. The point of measurement (sampling point) will be in the upper section of the flare (80 % of total flare height). Sampling will be conducted with appropriate sampling probes adequate to high temperatures level (e.g. incolloy probes). Continuous monitoring frequency. Values will be averaged at least hourly.
QA/QC procedures:	Analysers are periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check are performed by comparison with a standard gas.
Any comment:	-

Data / Parameter:	$\mathbf{fv_{CH4,FG,h}}$
Data unit:	mg/m_n^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h
Source of data:	Measurements by Arel Enerji using a continuous gas analyser. Values will be averaged on hourly time interval.
Measurement procedures (if any):	0. The project applies a high efficiency flare and thus, no methane contents in the exhaust gas of the flare are

	expected.
Monitoring frequency:	Extractive sampling analysers with water and particulates removal devices. The point of measurement (sampling point) will be the upper section of the flare. Sampling will be conducted with appropriate sampling probes adequate to high temperatures level (e.g. incolloy probes). Equipment will provide an minimum accuracy of +/- 1 %.
QA/QC procedures:	Analysers are periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check are performed by comparison with a standard gas.
Any comment:	Monitoring of this parameter is only applicable for enclosed flares and continuous monitoring of the flare efficiency. "Measurement instruments may read ppmv or %. To convert ppmv to mg/m^3 simply multiply by 0.716. 1% equals 10,000 ppmv."

Data / Parameter:	**T_{flare}**
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data:	Continuous measurements by Arel Enerji.
Measurement procedures (if any):	> 500°C (The ex-ante estimation of the amount of methane destroyed by the project activity $MD_{project,y}$ is based on the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (version 04, EB 41, Report Annex 10)
Monitoring frequency:	Temperature of the exhaust gas stream in the flare is measured by a Type K thermocouple (on light alloy containing nickel, which particularly adapt for high temperature measurements in oxidant atmosphere). Temperatures above 500°C indicate that a significant amount of gases is still being burnt and that the flare is operating.
QA/QC procedures:	Thermocouples should be replaced or calibrated every year
Any comment:	-

Data / Parameter:	**P_{LFG}**
Data unit:	Pa
Description:	Pressure of the landfill gas
Source of data:	Continuous measurements by Arel Enerji.

Measurement procedures (if any):	
Monitoring frequency:	Continuous
QA/QC procedures:	
Any comment:	The pressure of the gas is required to determine the density of the methane combusted. If the landfill gas flow meter employed measures flow, pressure and temperature and displays or outputs the normalised flow of landfill gas, then there is no need for separate monitoring of pressure and temperature of the landfill gas

Data / Parameter:	**Operation of the energy plant**
Data unit:	Hours
Description:	Operation of the energy plant
Source of data:	Recording by Arel Enerji.
Measurement procedures (if any):	n.a.
Monitoring frequency:	Monitored annualy
QA/QC procedures:	
Any comment:	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when its operational.

Data / Parameter:	$EG_{facility,y}$
Data unit:	MWh
Description:	Net electricity delivered to the grid
Source of data:	The data from the Electricity Meters are the basis for the settlement notification of PMUM. Data are gathered electronically from the meters by TEIAS and stored in secured website of PMUM, which is accessible to project developer with a private password. For monitoring, the monthly settlement notification of PMUM shall be used as source of data.
Value of data	**11,200 MWh/year**
Description of measurement methods and procedures to be applied:	• Regarding the electricity meters: two meters will be placed (one main and one reserve). at the TEIAS substation. These meters are sealed by TEIAS and intervention by project proponent is not possible. The fact that two meters are installed in a redundant manner keeps the uncertainty level of the only parameter for baseline calculation low. High data quality of this parameter is not only in the interest of the emission reduction monitoring, but paramount for the business relation between the plant operator and the electricity buyer. • Measured hourly and readings monthly: Monthly

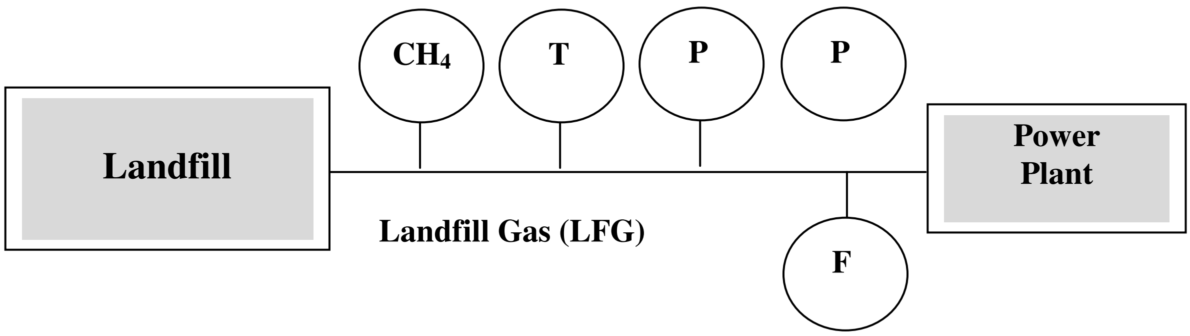
	settlement notifications of PMUM consist hourly electricity production and withdrawn from the grid • Since the meters are reading electricity supplied to the system and withdrawn from the system separately, the net electricity amount supplied to the grid will be calculated by electricity supplied minus electricity withdrawn which will be taken from monthly settlement notifications. Thus with this procedure is monitored sufficient and no extra Monitoring has to be implemented. The above described measurement method follows Article 81 of the official regulation "Electricity Market Balancing And Settlement Regulation"[27]
QA/QC procedures to be applied:	According to the Article 2 of the 'Communiqué Regarding the Meters to be used in the Electricity Market '[28] (Communiqué): '*The meters to be used in the electricity market shall be compliant with the standards of Turkish Standards Institute or IEC and have obtained* ***"Type and System Approval" certificate from the Ministry of Trade and Industry.'*** Therefore, Ministry of Trade and Industry (Ministry) is responsible from control and calibration of the meters. Paragraph b) of the Article 9 of the 'Regulation of Metering and Testing of Metering Systems'[29] (Regulation) of Ministry states that: ' *b) Periodic tests of meters of electricity, water, coal gas, natural gas and current and voltage transformers are done* ***every 10 years****.'* Therefore periodic calibration of the meters will be done every 10 years. Also according to Article 67 (page 20) of this regulation, the calibration shall be done in calibration stations which have been tested and approved by Ministry of Trade and Industry. Article 10-d) of Communiqué requires the meters shall be three phase four wire and Article 64 of Regulation clearly states how calibration shall be performed for this kind of meters. According to Article 3 of System Usage Agreement[30] done by Arel Enerji and TEIAS; other than periodic tests, if a

[27] See, http://www.epdk.org.tr/mevzuat/yonetmelik/elektrik/dengeleme/yeni/degisiklik06112010.docpage13
[28] See, http://www.epdk.org.tr/english/regulations/electric/meters.doc, (page 6)
[29] See, http://www.sanayi.gov.tr/download/osgm/olcu_aletleri_muayene_yonetmelik.zip (page 2)
[30] See, http://www.teias.gov.tr/sistemkullanim1.doc , (page 3, 2-b)

	party alleges the meters are not working appropriately tests of the meters will be done by presence of both parties. If, after controls, it is seen that the meter is not working appropriately, the measurements of reserve meters are taken into account beginning from date both meters are reading the same (page 3, 2-c) As above mentioned, the data acquisition and management and quality assurance procedures that are anyway in place, no additional procedures have to be established for the monitoring plan.
Any comment:	

B.7.2 Description of the monitoring plan:

The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform(s) and the electricity generating unit(s) to determine the quantities as shown in Figure 3. The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared. The main variables that need to be determined are the quantity of methane actually captured ($MD_{project,y}$) *and* the quantity of methane used to generate electricity ($MD_{electricity,y}$). The methodology also measures the energy generated by use of LFG ($EL_{LFG,y}$, $ET_{LFG,y}$).



Measurements:
CH_4= Fraction of CH_4
T= Temperature
P= Pressure
F= Flow of LFG (m^3)

Figure 2 Monitoring Plan

- The amount of landfill gas generated (in m^3, using continuous flow meter), where the total quantity ($LFG_{total,y}$) as well as the quantity fed to the power plant ($LFG_{electricity,y}$) measured continuously.
- The fraction of methane in the landfill gas ($w_{CH4,y}$) measured with a continuous analyzer;

Monitoring organisation

Responsibilities for the data processing and management lie with Arel Enerji. Therefore, it will team up a VER team. This team will be responsible for monitoring all data required to estimate emission reductions. FutureCamp Turkey will also assist VER Team with regards to the monitoring aspects of the project.

Data collection

The projected plant is to be operated by an automatically electrical control system measuring actual LFG flow and its composition to avoid the interference of ambient air into the extraction wells and thereby optimize the gas extraction.

1) Flow measurements

Flow of landfill gas (collected by the system and subsequently combusted) is measured by flow measuring device suitable for measuring the velocity and volumetric flow of a gas. The flow measurements are taken within the piping itself, and the flow sensors are connected to a transmitter that is capable of collecting and sending continuous data to a recording device such as a data logger.

Calibration: The flow sensors are calibrated according to specified temperature, pressure and composition of the gas as per the manufacturer's recommendation. The equipment selected will allow dynamic compensation for these parameters, normalized to standard temperature, pressure, and gas composition. The accuracy of a flow meter depends on the design of the equipment, and the specific type of sensor used, however equipment will be available that will provide a minimum accuracy of +/- 2% by volume.

2) Gas Quality and efficiency of the flare

Concentration of methane and oxygen in the landfill gas stream and the exhaust gas of the flare are the parameters that are essential for calculation of emission reductions, as well as the safe and efficient operation of the system.

Concentration of methane and oxygen in the landfill gas stream are controlled by a common sample line installed in the main collection system piping and measured continuously by two separate sensors, for methane and oxygen each. Although compensation for temperature and pressure is not required for the methane and oxygen sensors, the sensors are designed to operate within specified temperature and pressure conditions.
Concentration of methane and oxygen in the exhaust gas stream are monitored by a common sample line installed in the upper section of the flare.

Calibration: Analysers are periodically calibrated according to the manufacturer's recommendation. Calibration equipment will provide an accuracy of +/- 1% by volume.

Data records and storage

The most important parameters (Gas quantities, methane/Oxygen concentrations, Temperatures) will be monitored on-line and all data will be stored in the monitoring station on the landfill site.

All process parameters will be stored in the data-logger of the degassing installation. Once a day the data will be transferred to the monitoring station on the landfill site. The monitoring station is a PC containing a

- modem for connection with the data-logger of the degassing installation,
- visualization system of the process for operating purposes,
- database to archive the received process data,
- system to provide alarm signals to the operators.

Electronically backup of the data will be conducted on a daily basis. A hard copy backup of all relevant data will be printed out monthly. Calibration records for all instrumentation will be constantly collected and archived.

All data and records required for verification will be kept for two years after the end of the project crediting period or the last issuance of CERs, whichever is later.

Data assessment and reporting

Arel Enerji will, if technically possible, execute remote monitoring of the installation. All relevant data will be analysed on a daily basis and registered, in both versions - electronical and paper.

Based on the recorded data in the electronic database, emission reduction calculations will be carried out monthly by the monitoring manager.
The annual monitoring report will contain the data required for the validation of the emission reductions and additionally may contain operational data from the collection system and flaring/gas engine system to illustrate that the system is well maintained and operating at peak efficiency. Records of regular maintenance performed will also be a component of the annual report.

Maintenance

Regular maintenance consists of the control of subsiding/distortion of the gas wells and the pipeline system. Local companies are in charge of those activities. In addition experts provided by the equipment supplier shall execute regularly the maintenance works at their equipments as foreseen in the maintenance plan.

Training
Training will be performed at commissioning stage by instruction and an accompanying guidebook, in order to ensure that the personnel on site perform their designated tasks at high standards. The technology supplier will deliver a guidebook in English. It will provide a short training of the local technical personnel for maintenance and calibration works. Chosen trainees shall have a good understanding the processes and technology of the installation of landfill gas extraction.

The guidebook will include an information about the following aspects:

- operation manual of the gas extraction system, flares and gas engines
- technical drawings of the installation
- maintenance instructions
- description of parts of the equipment
- telephone of a person who will be available in case of technical failures (a help desk shall be available for 24 hours per day in case of technical failures.)

Using the telephone helpdesk of supplier, the trained operators can however always inquire any technical support.

Monitoring personnel will be trained internally or externally at regular intervals during the crediting period. This will include training for landfill gas collection system balancing, monitoring equipment and calibration as well as impact of the monitoring on the CDM activity.

Detailed standard operation procedures will be developed and detailed after commissioning in October.

Emergency cases

VERs will not be claimed for periods in which the requirements of the monitoring methodology are not complied. Any failure of relevant equipment and monitoring equipment will be recorded including the time where respective equipment was out of order.

In case of failure at the degassing installation the following procedures should be performed:

No electrical power
If no electrical power is available, the blower of the degassing installation cannot operate, therefore no LFG stream is available and flow-meter cannot detect anything. In such situations no emission reductions are accounted for.

Failure of flow meter
The possibility of the flow meter failure is very small. In the case of flow meter brake down, the instrument will be replaced by a spare one as soon as possible in order to minimise the operation time with no flow signal. Despite a rapid exchange, the degassing installation will operate for a short time without the flow signal. To determine the flow during this interval, the lowest hourly flow rate of the last 7 days will be used.

Failure methane analyser
In case of methane analyser brake down, the instrument will be exchanged to minimise the operation without the measurement. Despite this quick exchange the degassing installation will operate a short time without CH_4-signal. To determine the CH_4-content during this interval the lowest CH_4-content of the last 7 days will be used.

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

Date of completion: 19/01/2012 (Version 1)

Name of entity determining the baseline:
Farız Taşdan
FutureCamp İklim ve Enerji Ltd. Şti
(FutureCamp Turkey - project consultant)
Tel : +90 312 481 21 42
Fax : +90 312 480 88 10
e-mail : fariz.tasdan@futurecamp.com.tr
Contributor: Arel Enerji Üretim Sanayi ve Ticaret A.Ş.

FutureCamp Turkey is not a project participant

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:

>>
Starting date of the project activity is 19/08/2011, which is the date of electromechanical contract signature.

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

>>
The expected lifetime of the project activity is10 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:

>>
01.03.2012

C.2.1.2. Length of the first crediting period:

>>
7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
NA

C.2.2.2. Length:

>>
NA

SECTION D. Environmental impacts

>>

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

>>
Detailed information regarding the environmental impacts is provided in the Gold Standard Passport, which is also available to DOE.

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:

There have not been identified any significant environmental impacts of the project.

SECTION E. Stakeholders' comments

>>

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

Detailed information regarding the stakeholder comments is provided in the Gold Standard Passport, which is also available to DOE.

E.2. Summary of the comments received:

>>
Detailed information regarding the stakeholder comments is provided in the Gold Standard Passport, which is also available to DOE.

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

>>

Detailed information regarding the stakeholder comments is provided in the Gold Standard Passport, which is also available to DOE.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Arel Çevre Yatırımları ve Enerji Üretim Tic. Ltd. Şti (Arel Enerji)
Street/P.O.Box:	Sağlık Mah. Ataç - 1 Sok. No: 7/6
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FAX:	
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Title:	Project Manager
Salutation:	Mr.
Last Name:	Anlı
Middle Name:	
First Name:	Aygün
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	anli@arelenerji.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE INFORMATION FOR LANDFILL SITE

Waste types

The Afyonkarahisar landfill site has started its operation in 2009. Currently approx. 1000 tonnes of waste is received by the site.

Composition of waste at Afyonkarahisar landfill site:

Paper and carton	4%
Kitchen waste	55%
Garden waste/ fruits	3%
Textiles	1%
Wood	2%
Total organic	65%
Glass/metal	6%
Plastics	14%
Non-recyclable construction waste (stones, mortar)	3%
Ash/minerals	4%
Fine fractions	2%
Bones/ rubber	4%
Bulky waste	2%
Total inorganic	35 %
Total	100 %

Annex 4

BASELINE INFORMATION FOR ELECTRICITY PRODUCTION

Calculation of Total CO_2 from OM Power Plants:

Tablo 21: HVi,y (Heating Values for Fossil Fuels for Electricity Generation (TCal)

Energy Sources	2007	2008	2009
Hard Coal+Imported Coal	32.115	33.310	35.130
Lignite	100.320	108.227	97.652
Fuel Oil	21.434	20.607	15.160
Diesel Oil	517	1.328	1.830
Lpg	0	0	1
Naphta	118	113	84
Natural Gas	179.149	189.057	186.266

Tablo 22: FCi,y (Fuel Consumptions for Fossil Fuels for Electricity Generation (million m3 for Natural Gas and ton for others)

Energy Sources	*2007*	*2008*	*2009*
Hard Coal+Imported Coal	*6.029.143*	*6.270.008*	*6.621.177*
Lignite	*61.223.821*	*66.374.120*	*63.620.518*
Fuel Oil	*2.250.686*	*2.173.371*	*1.594.321*
Diesel Oil	*50.233*	*131.206*	*180.857*
LPG	*0*	*0*	*111*
Naphta	*11.441*	*10.606*	*8.077*
Natural Gas	*20.457.793*	*21.607.635*	*20.978.040*

1	**Tcal=**	**4.1868**	**TJ**

Tablo 23: NCVi,y (Average Net Calorific Values for Fossil Fuels for Electricity Generation; TJ/million m3 for Natural Gas and TJ/kton for others) and EFi (Emission Factor of Fossil Fuels)

Energy Sources	*NCVi 2007 (TJ/Gg)*	*NCVi 2008 (TJ/Gg)*	*NCVi 2009 (TJ/Gg)*	*EFCO2, (kg/TJ)*
Hard Coal+Imported Coal	*22,30*	*22,24*	*22,21*	*89,50*
Lignite	*6,86*	*6,83*	*6,43*	*90,90*
Fuel Oil	*39,87*	*39,70*	*39,81*	*72,60*
Diesel Oil	*43,09*	*42,38*	*42,37*	*72,60*
LPG	*0,00*	*0,00*	*37,72*	*61,60*
Naphta	*43,18*	*44,61*	*43,54*	*69,30*
Natural Gas	*36,66*	*36,63*	*37,17*	*54,30*

Tablo 24: CO_2 Emission by each Fossil Fuels Types (ktCO2e)

Energy Sources	*2007*	*2008*	*2009*
Hard Coal+Imported Coal	*12.034*	*12.482*	*13.164*
Lignite	*38.180*	*41.189*	*37.164*
Fuel Oil	*6.515*	*6.264*	*4.608*
Diesel Oil	*157*	*404*	*556*
Lpg	*0*	*0*	*0*
Naphta	*34*	*33*	*24*
Natural Gas	*40.728*	*42.981*	*42.346*
TOTAL	*97.649*	*103.352*	*97.863*

PART C: Identification of Sample Group

Tablo 25: Sample Group PPs for BM Emission Factor Calculation

Name of Power Plant	Capacity (MW)	Average Genera-tion (GWh)	Fuel Type	Date of Operation
ÇEBİ ENERJİ GT	43,4	340,1	N. Gas	23.08.2005
ENTEK ELK.A.Ş.KOÇ ÜNİ.GR I-II	2,3	19,0	N. Gas	07.02.2005
KAREGE GR IV-V	18,1	141,9	N. Gas	07.04.2005
KARKEY(SİLOPİ-4) GR-IV	6,2	47,2	Fuel Oil	30.06.2005
KARKEY(SİLOPİ-4) GR-V	6,8	51,9	Fuel Oil	23.12.2005
METEM ENERJİ(Hacışıramat) GR I-II	7,8	58,0	N. Gas	29.01.2005
METEM ENERJİ(Peliklik) GR I-II-III	11,7	89,0	N. Gas	29.01.2005
NOREN ENERJİ GR-I	8,7	70,0	N. Gas	24.08.2005
NUH ENERJİ-2 GR I	47,0	319,7	N. Gas	24.05.2005
ZORLU ENERJİ KAYSERİ GR-I-II-III	149,9	1.144,1	N. Gas	22.07.2005
ZORLU ENERJİ KAYSERİ GR-IV	38,6	294,9	N. Gas	26.10.2005
ZORLU ENERJİ YALOVA GR I-II	15,9	122,0	N. Gas	26.11.2005
TEKTUĞ(Kargılık) GR I-II	23,9	83,0	Hydro (Run of River)	25.04.2005
İÇTAŞ ENERJİ(Yukarı Mercan) GR I-II	14,2	44,0	Hydro (Run of River)	02.05.2005
MURATLI GR I-II	115,0	444,0	Hydro (with Dam)	03.06.2005
BEREKET EN.(DALAMAN) GR XIII-XIV-XV	7,5	35,8	Hydro (Run of River)	16.07.2005
YAMULA GRUP I-II	100,0	422,0	Hydro (with Dam)	31.07.2005
SUNJÜT(RES) GR I-II	1,2	2,4	Wind	23.04.2005
EKOTEN TEKSTİL GR-I	1,9	14	N. Gas	16.02.2006
ERAK GİYİM GR-I	1,4	10,0	N. Gas	22.02.2006
ALARKO ALTEK GR-III	21,9	173,0	Steam	23.02.2006
AYDIN ÖRME GR-I	7,5	60,0	N. Gas	25.02.2006
NUH ENERJİ-2 GR-II	26,1	180,1	Steam	02.03.2006
MARMARA ELEKTRİK (Çorlu) GR-I	8,7	63,0	N. Gas	13.04.2006
MARMARA PAMUK(Çorlu) GR-I	8,7	63,0	N. Gas	13.04.2006
ENTEK (Köseköy) GR-IV	47,6	378,2	N. Gas	14.04.2006

ELSE TEKSTİL (Çorlu) GRI-II	3,2	25,0	N. Gas	15.04.2006
SÖNMEZ ELEKTRİK (Çorlu) GRI-II	17,5	126,0	N. Gas	03.05.2006
MENDERES ELEKTRİK GR-I	8,0	56,0	Geothermal	10.05.2006
KASTAMONU ENTEGRE (Kayseri) GR-I	7,5	54,0	N. Gas	24.05.2006
BOZ ENERJİ GR-I	8,7	70,0	N. Gas	09.06.2006
ADANA ATIK SU ARITMA TESİSİ	0,8	6,0	Biogas	09.06.2006
AMYLUM NİŞASTA (ADANA)	14,3	34,0	N. Gas	09.06.2006
ŞIKMAKAS (Çorlu) GR-I	1,6	13,0	N. Gas	22.06.2006
ELBİSTAN B GR-III	360,0	2.340,0	Lignite	23.06.2006
ANTALYA ENERJİ GR I-II-III-IV	34,9	245,0	N. Gas	29.06.2006
HAYAT TEM. VE SAĞLIK GR I-II	15,0	108,0	N. Gas	30.06.2006
EKOLOJİK EN. (Kemerburgaz) GR-I	1,0	6,0	Waste Heat	31.07.2006
EROĞLU GİYİM (Çorlu) GR-I	1,2	9,0	N. Gas	01.08.2006
CAM İŞ ELEKTRİK (Mersin) GR-I	126,1	1.008,0	N. Gas	13.09.2006
ELBİSTAN B GR-II	360,0	2.340,0	Lignite	17.09.2006
YILDIZ ENT. AĞAÇ (Kocaeli) GR-I	6,2	40,0	N. Gas	21.09.2006
ÇERKEZKÖY ENERJİ GR-I	49,2	390,0	N. Gas	06.10.2006
ENTEK (Köseköy) GR-V	37,0	293,9	N. Gas	03.11.2006
ELBİSTAN B GR-IV	360,0	2.340,0	Lignite	13.11.2006
ÇIRAĞAN SARAYI GR-I	1,3	11,0	N. Gas	01.12.2006
ERTÜRK ELEKTRİK Tepe RES GR-I	0,9	2,0	Wind	22.12.2006
AKMAYA (Lüleburgaz) GR-I	6,9	50,0	N. Gas	23.12.2006
BURGAZ (Lüleburgaz) GR-I	6,9	54,0	N. Gas	23.12.2006
ŞANLIURFA GR I-II	51,8	124,0	Hydro (Run of River)	01.03.2006
BEREKET ENERJİ GÖKYAR HES 3 Grup	11,6	43,3	Hydro (Run of River)	05.05.2006
AFYONKARAHİSAR EN. Zamantı Bahçelik GR I-II	4,2	16,7	Hydro (Run of River)	31.05.2006
SU ENERJİ (Kayseri) GR I-II	4,6	20,7	Hydro (Run of River)	27.06.2006
BEREKET EN. (Mentaş Reg) GR I-II	26,6	108,7	Hydro (Run of River)	31.07.2006
EKİN (Başaran Hes) (Nazilli)	0,6	4,5	Hydro (Run of River)	11.08.2006
ERE (Sugözü rg. Kızıldüz hes) GR I-II	15,4	31,6	Hydro (Run of River)	08.09.2006
ERE (AKSU REG. Ve ŞAHMALLAR HES) GR I-II	14,0	26,7	Hydro (Run of River)	16.11.2006
TEKTUĞ (Kalealtı) GR I-II	15,0	52,0	Hydro (Run of River)	30.11.2006
BEREKET EN. (Mentaş Reg) GR III	13,3	54,4	Hydro (Run of River)	13.12.2006
HABAŞ (ALİAĞA-ADDITION)	9,1	35,3	N. Gas	02.05.2007
BOSEN	-123,5	0,0	N. Gas	2007
MODERN ENERJİ	5,2	38,0	N. Gas	2007
Acıbadem Sağlık Hiz.ve Tic.A.Ş(Kadıköy Hast.)(İstanbul/Kadıköy)	0,5	4,0	N. Gas	19.06.2007
Acıbadem Sağlık Hiz.ve Tic.A.Ş(Kozyatağı Hast.)(İstanbul/Kadıköy)	0,6	5,0	N. Gas	23.10.2007
Acıbadem Sağlık Hiz.ve Tic.A.Ş(Nilüfer/BURSA)	1,3	11,0	N. Gas	28.08.2007
AKATEKS Tekstil Sanayi ve Ticaret A.Ş.	1,8	14,0	N. Gas	30.07.2007

FLOKSER TEKSTİL SAN.AŞ.(Çatalça/istanbul)(SüetserTesisi)	2,1	17,0	N. Gas	03.12.2007
FLOKSER TEKSTİL SAN.AŞ.(Çatalça/istanbul)(Poliser Tesisi)	2,1	17,0	N. Gas	03.12.2007
FRİTOLAY GIDA SAN.VE TİC. AŞ.	0,5	4,0	N. Gas	23.01.2007
KIVANÇ TEKSTİL SAN.ve TİC.A.Ş.	3,9	33,0	N. Gas	20.03.2007
KİL-SAN KİL SAN.VE TİC. A.Ş	3,2	25,0	N. Gas	19.02.2007
SÜPERBOY BOYA SAN.ve Tic.Ltd.Şti.(Büyükçekmece/İstanbul)	1,0	8,0	N. Gas	05.12.2007
SWİSS OTEL(Anadolu Japan Turizm A.Ş (İstanbul)	1,6	11,0	N. Gas	01.08.2007
TAV Esenboğa Yatırım Yapım ve İşetme AŞ./ANKARA	3,9	33,0	N. Gas	19.09.2007
BOĞAZLIYAN ŞEKER	16,4	0,0	Liqued Fuel + N.Gas	2007
KARTONSAN	5,0	40,0	Liqued Fuel + N.Gas	2007
ESKİŞEHİR END.ENERJİ	3,5	26,8	Liqued Fuel + N.Gas	2007
İGSAŞ	2,2	15,2	Liqued Fuel + N.Gas	2007
BİS Enerji Üretim AŞ.(Bursa)(Addition)	43,0	354,8	N. Gas	30.05.2007
Aliağa Çakmaktepe Enerji A.Ş.(Aliağa/İZMİR)	34,8	278,0	N. Gas	13.09.2007
BİS Enerji Üretim AŞ.(Bursa)(Revision)	28,3	0,0	N. Gas	11.09.2007
BİS Enerji Üretim AŞ.(Bursa)(Addition)	48,0	396,1	N. Gas	30.08.2007
BOSEN ENERJİ ELEKTRİK AŞ.	142,8	1.071,0	N. Gas	18.01.2007
SAYENERJİ ELEKTRİK ÜRETİM AŞ. (Kayseri/OSB)	5,9	47,0	N. Gas	03.07.2007
T ENERJİ ÜRETİM AŞ.(İSTANBUL)	1,6	13,0	N. Gas	04.04.2007
ZORLU EN.Kayseri (1 GT Addition)	7,2	55,0	N. Gas	17.01.2007
SİİRT	25,6	190,0	Fuel Oil	2007
Mardin Kızıltepe	34,1	250,0	Fuel Oil	2007
KAREN	24,3	180,0	Fuel Oil	2007
İDİL 2 (PS3 A- 2)	24,4	180,0	Fuel Oil	2007
BORÇKA HES	300,6	1.039,0	Hydro (With Dam)	27.02.2007
TEKTUĞ(Keban River)	5,0	32,0	Hydro (run of river)	08.05.2007
YPM Ener.Yat.AŞ.(Altıntepe Hydro)(Sivas/Suşehir)	4,0	18,0	Hydro (run of river)	06.06.2007
YPM Ener.Yat.AŞ.(Beypınar Hydro)(Sivas/Suşehir)	3,6	18,0	Hydro (run of river)	06.06.2007
YPM Ener.Yat.AŞ.(Konak Hydro)(Sivas/Suşehir)	4,0	19,0	Hydro (run of river)	19.07.2007
KURTEKS Tekstil A.Ş./Kahramanmaraş(KARASU HES-Andırın)	2,4	19,0	Hydro (run of river)	28.11.2007
İSKUR TEKSTİL (SÜLEYMANLI HES)	4,6	18,0	Hydro (run of river)	30.12.2007
ÖZGÜR ELK.AŞ.(K.MARAŞ)(Tahta)	6,3	27,0	Hydro (run of river)	03.05.2007
ÖZGÜR ELK.AŞ.(K.MARAŞ)(Tahta)(Addition)	6,3	27,0	Hydro (run of river)	24.05.2007
MB ŞEKER NİŞASTA SAN.A.Ş. (Sultanhanı)	8,8	60,0	Natural Gas	30.06.2008
AKSA ENERJİ (Antalya)	183,8	1.290,0	Natural Gas	2008

AKSA ENERJİ (Manisa)	52,4	370,0	Natural Gas	2008
ANTALYA ENERJİ (Addition)	17,5	122,3	Natural Gas	2008
ATAÇ İNŞAAT SAN. A.S.B. (ANTALYA)	5,4	37,0	Natural Gas	2008
BAHÇIVAN GIDA (LÜLEBURGAZ)	1,2	8,0	Natural Gas	2008
CAN ENERJİ (Çorlu - Tekirdağ) (Addition)	52,4	304,2	Natural Gas	2008
FOUR SEASONS OTEL (ATİK PASHA TUR. A.Ş.)	1,2	7,0	Natural Gas	2008
FRİTOLAY GIDA SAN.VE TİC. AŞ. (Addition)	0,1	4,0	Natural Gas	2008
KARKEY (SİLOPİ-5) (154 kV) (Addition)	14,8	103,2	Fuel Oil	2008
MELİKE TEKSTİL (GAZİANTEP)	1,6	11,0	Natural Gas	2008
MİSİS APRE TEKSTİL BOYA EN. SAN.	2,0	14,0	Natural Gas	2008
MODERN ENERJİ (LÜLEBURGAZ)	13,4	94,1	Natural Gas	2008
POLAT TURZ. (POLAT RENAISSANCE İST. OT.)	1,6	11,0	Natural Gas	2008
SARAYKÖY JEOTERMAL (Denizli)	6,9	50,0	Geothermal	2008
SÖNMEZ Elektrik (Addition)	8,7	67,3	Natural Gas	2008
AKKÖY ENERJİ (AKKÖY I HES)	101,9	408,0	Hydro (with Dam)	2008
ALP ELEKTRİK (TINAZTEPE) ANTALYA	7,7	29,0	Hydro (run of river)	2008
CANSU ELEKTRİK (MURGUL/ARTVİN)	9,2	47,0	Hydro (run of river)	2008
DAREN HES ELKT. (SEYRANTEPE BARAJI VE HES)	49,7	182,0	Hydro (With Dam)	2008
DEĞİRMENÜSTÜ EN. (KAHRAMANMARAŞ)	25,7	69,0	Hydro (With Dam)	2008
GÖZEDE HES (TEMSA ELEKTRİK) BURSA	2,4	10,0	Hydro (run of river)	2008
H.G.M ENERJİ (KEKLİCEK HES) (Yeşilyurt)	8,7	18,0	Hydro (run of river)	2008
HİDRO KNT. (YUKARI MANAHOZ REG. VE HES)	22,4	79,0	Hydro (run of river)	2008
İÇ-EN ELK. (ÇALKIŞLA REGÜLATÖRÜ VE HES)	7,7	18,0	Hydro (run of river)	2008
KALEN ENERJİ (KALEN II REGÜLAT. VE HES)	15,7	50,0	Hydro (run of river)	2008
MARAŞ ENERJİ (FIRNIS REGÜLATÖRÜ VE HES)	7,2	36,0	Hydro (run of river)	2008
SARMAŞIK I HES (FETAŞ FETHİYE ENERJİ)	21,0	96,0	Hydro (run of river)	2008
SARMAŞIK II HES (FETAŞ FETHİYE ENERJİ)	21,6	108,0	Hydro (run of river)	2008
TORUL	105,6	322,0	Hydro (With Dam)	2008
YEŞİL ENERJİ ELEKTRİK (TAYFUN HES)	0,8	5,0	Hydro (run of river)	2008
ERDEMİR(Ereğli-Zonguldak)	36,1	217,95	Natural Gas	2009

ARENKO ELEKTRİK ÜRETİM A.Ş. (Denizli)	12	84	Natural Gas	2009
TAV İSTANBUL TERMİNAL İŞLETME. A.Ş.	6,52	54,56	Natural Gas	2009
AKSA AKRİLİK KİMYA SN. A.Ş. (YALOVA)	70	539	Natural Gas	2009
KASAR DUAL TEKSTİL SAN. A.Ş. (Çorlu)	5,67	38	Natural Gas	2009
SÖNMEZ ELEKTRİK(Uşak) (Addition)	8,73	67,29	Natural Gas	2009
GÜRMAT ELEKT. (GÜRMAT JEOTERMAL)	47,4	313	Geothermal	2009
DELTA ENERJİ ÜRETİM VE TİC.A.Ş.	60	467	Natural Gas	2009
KEN KİPAŞ ELKT. ÜR.(KAREN) (K.Maraş)	17,46	73,36	Natural Gas	2009
TESKO KİPA KİTLE PAZ. TİC. VE GIDA A.Ş.	2,33	18	Natural Gas	2009
NUH ÇİMENTO SAN. TİC. A.Ş.(Nuh Çim.) (Addition)	46,95	328,65	Natural Gas	2009
SİLOPİ ELEKTRİK ÜRETİM A.Ş.	135,000	945,00	Asphaltit	2009
MAURİ MAYA SAN. A.Ş.	2,000	16,52	Natural Gas	2009
AKSA ENERJİ (Antalya) (Addition)	300,000	2310,00	Natural Gas	2009
ANTALYA ENERJİ (Addition)	41,820	302,24	Natural Gas	2009
MARMARA PAMUKLU MENS. SN.TİC.A.Ş.	34,920	271,68	Natural Gas	2009
AKSA ENERJİ (Antalya) (Addition)	300,000	2310,00	Natural Gas	2009
ZORLU ENERJİ (B.Karıştıran) (Addition)	49,530	395,21	Natural Gas	2009
İÇDAŞ ÇELİK (Addition)	135,000	961,67	Imported coal	2009
GLOBAL ENERJİ (PELİTLİK)	8,553	65,31	Natural Gas	2009
RASA ENERJİ (VAN)	78,570	500,00	Natural Gas	2009
DELTA ENERJİ ÜRETİM VE TİC.A.Ş. (Addition)	13,000	101,18	Natural Gas	2009
İÇDAŞ ÇELİK (Addition)	135,000	961,67	Imported coal	2009
DALSAN ALÇI SAN. VE TİC. A.Ş.	1,165	9,00	Natural Gas	2009
AK GIDA SAN. VE TİC. A.Ş. (Pamukova)	7,500	61,00	Natural Gas	2009
CAM İŞ ELEKTRİK (Mersin) (Addition)	126,100	1008,00	Natural Gas	2009
SELKASAN KAĞIT PAKETLEME MALZ. İM.	9,900	73,00	Natural Gas	2009
TAV İSTANBUL TERMİNAL İŞLETME. A.Ş.	3,260	27,28	Natural Gas	2009
DESA ENERJİ ELEKTRİK ÜRETİM A.Ş.	9,800	70,00	Natural Gas	2009
FALEZ ELEKTRİK ÜRETİMİ A.Ş.	11,748	88,00	Natural Gas	2009
AKSA ENERJİ (MANİSA) (Addition)	62,900	498,07	Natural Gas	2009
SİLOPİ ELEKTRİK ÜRETİM A.Ş.(ESENBOĞA)	44,784	315,00	Fuel Oil	2009
TAŞOVA YENİDEREKÖY HES (HAMEKA A.Ş.)	1,980	10,00	Hydro (run of river)	2009
TEKTUĞ (Erkenek)	6,000	24,00	Hydro (run of river)	2009

BAĞIŞLI REG. VE HES (CEYKAR ELEKT.)	9,857	32,96	Hydro (run of river)	2009
DEĞİRMENÜSTÜ EN. (KAHRAMANMARAŞ)	12,850	35,28	Hydro (run of river)	2009
BAĞIŞLI REG. VE HES (CEYKAR ELEKT.)	19,714	66,04	Hydro (run of river)	2009
TOCAK I HES (YURT ENERJİ ÜRETİM SN.)	4,760	13,00	Hydro (run of river)	2009
BEYOBASI EN. ÜR. A.Ş. (SIRMA HES)	5,880	23,00	Hydro (run of river)	2009
ÖZYAKUT ELEK. ÜR.A.Ş. (GÜNEŞLİ HES)	1,800	8,00	Hydro (run of river)	2009
LAMAS III - IV HES (TGT ENERJİ ÜRETİM)	35,674	150,00	Hydro (run of river)	2009
YPM SEVİNDİK HES (Suşehri/SİVAS)	5,714	36,00	Hydro (run of river)	2009
YPM GÖLOVA HES (Suşehri/SİVAS)	1,050	3,00	Hydro (run of river)	2009
BEREKET ENERJİ (KOYULHİSAR HES)	42,000	329,00	Hydro (run of river)	2009
KALEN ENERJİ (KALEN I - II HES)	15,650	52,17	Hydro (run of river)	2009
CİNDERE HES (Denizli)	19,146	58,00	Hydro (With Dam)	2009
ŞİRİKÇİOĞLU EL.(KOZAK BENDİ VE HES)	4,400	15,00	Hydro (run of river)	2009
AKUA ENERJİ (KAYALIK REG. VE HES)	5,800	39,00	Hydro (run of river)	2009
KAYEN ALFA ENERJİ (KALETEPE HES)	10,200	37,00	Hydro (run of river)	2009
OBRUK HES	212,400	473,00	Hydro (With Dam)	2009
ANADOLU ELEKTRİK (ÇAKIRLAR HES)	16,158	60,00	Hydro (run of river)	2009
AKÇAY HES ELEKTRİK ÜR. (AKÇAY HES)	28,780	95,00	Hydro (run of river)	2009
ELESTAŞ ELEKTRİK (YAYLABEL HES)	5,100	20,00	Hydro (run of river)	2009
ERVA ENERJİ (KABACA REG. VE HES)	4,240	16,50	Hydro (run of river)	2009
ELESTAŞ ELEKTRİK (YAZI HES)	1,109	6,00	Hydro (run of river)	2009
ERVA ENERJİ (KABACA REG. VE HES)	4,240	16,50	Hydro (run of river)	2009
TÜM ENERJİ (PINAR REG. VE HES)	30,090	138,00	Hydro (run of river)	2009
TEKTUĞ (Erkenek) (Additon)	6,514	26,00	Hydro (run of river)	2009
SARITEPE HES (GENEL DİNAMİK SİS.EL.)	2,450	10,00	Hydro (run of river)	2009
UZUNÇAYIR HES (Tunceli)	27,330	105,00	Hydro (With Dam)	2009
YEŞİLBAŞ ENERJİ (YEŞİLBAŞ HES)	14,000	56,00	Hydro (run of river)	2009
SARITEPE HES (GENEL DİNAMİK SİS.EL.)	2,450	10,00	Hydro (run of river)	2009

Annex 5

MONITORING INFORMATION

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