CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

- Djebel Chekir Landfill Gas Recovery and Flaring Project – Tunisia
- Version 03
- Date of the document: 5 April 2006

A.2. Description of the project activity:

The National Waste Management Agency of Tunisia (ANGED) is Government agency willing to implement a Gas Recovery and Flaring Project at the Djebel Chekir landfill. The objective of the project activity is to generate greenhouse gas GHG emission reductions while serving sustainable development purposes, and providing additional resources to environment protection in Tunisia.

With a nominal capacity of 700,000 tons of waste/year, Djebel Chekir landfill is located close to Tunis Capital, and is the first and largest controlled landfill of its kind in Tunisia. The landfill has been put into operation in 1999 and should stop receiving municipal wastes by 2010. Up to 2005, the landfill has received about 3.92 Million tons of wastes in Cells 1, 2 and 3, and 3.5 additional Million tons of wastes should be landfilled over the period 2006-2010, in Cells 4 and 5.

Currently, the landfill is in an advanced anaerobic process, in particularly Cell 1 and 2, which were definitively covered with the upper sand layer since 2003.

The first year of its implementation (1999), the landfill was operated by the ANPE (National Agency for Environmental Protection). In 2000, a management contract was awarded to a private operator: SOMAGED, through a competitive bidding process for a five-year period (2000-2005). The contract with SOMAGED has been extended to June 2006, until a new landfill operator for the next five years-period is selected, through a new international bid, which is being launched.

Current contract with SOMAGED encompasses the usual responsibilities of landfill management, including technical activities, personnel, and the management and maintenance of stationary and mobile equipments, which are properties of ANGED. The contract stipulates an LFG recovery and treatment system as a unique site safety effort that is not required by Law. Although some rough technical description concerning the installation method of the wells, the contract neither describes characteristics of the LFG collection system and flaring equipment, nor does it mention how it would be operated and who would be bearing the cost of all the equipments.

Due to such unclear specifications and also inappropriate overall operating conditions of the landfill partly resulting from ANPE not being able to meet its own contractual commitments,

the LFG collection, evacuation and flaring was never implemented as it should have been. The only LFG wells installed at Djebel Chekir site were then 20 wells installed in Cell 1. But these wells have never been maintained, and were abandoned since year 2001. Due to this unsuccessful experience, no LFG recovery system was installed in cells 2 and 3. Overall, there was an evident technical, financial and operational lack of capacity to operate such LFG safety system in Tunisia.

A new contractor is being selected for the next five-year period (2006-2010) to manage the landfill, and a competitive bid was issued for that purpose. The new contractor should officially start operating the landfill by June-July 2006. The contractual clauses to operate the landfill for the period 2006-2010 do not include LFG recovery, collection or destruction process.

The purpose of the project activity is to implement an LFG recovery and flaring system, in order to reduce CH4 emissions for the benefit of global climate, and thus to generate Certified Emissions Reductions CERs.

The LFG recovery and flaring system will be financed by the National Waste Management Agency (ANGED), and operated by other private contractor. A competitive bid will be issued in order to recruit a specialized company for the purpose of designing, building and operating the LFG component of the landfill. However, in the case where separate contractors are selected, and in order to avoid a threat to the proper operation of the landfill by the new contractor managing the landfill in the period 2006-2010, the new contractor will be given incentives to optimize the generation of LFG.

Greenhouse emission reductions will result from the combustion of the recovered methane contained in the landfill gas. It is estimated that this project will reduce 3,696,644 tonnes of CO2 equivalent within a 10 year period (January 2007- December 2016)

<u>The project will have a significant contribution to sustainable development:</u>

First of all, the project activity would demonstrate, for the first time, the application of a World Standard methane capture system in Tunisia, and will allow for replicating such experience in the country.

Socio-economic potential benefits will include the development of endogenous capacities to better manage landfilling operations, the development of a number of employment opportunities in various infrastructure works involved: Wells building, Piping network, management and monitoring of the system, etc.

By recovering the LFG, it will also contribute to reduce pollution, and thus limit the landfill impact by preserving air quality, within the neighbouring human establishments.

In addition, the project will rehabilitate the leachate management in Cells 1, 2 and 3, and will install appropriate leachate management practices in Cells 4 and 5. In doing so, the project activity will reduce the impact of the landfill on the soil and on ground water resources, and thus preserve agricultural production and ensure population safety.

Furthermore, the project will contribute on voluntary basis to the National Solid Waste Management Programme, by allocating 25% of the ERs revenues to rehabilitate a number of existing dumps. By preventing these dumps continuously impacting soils, groundwater resources, air quality and public health, the financial resources provided by the project will therefore restore the ecological equilibrium in the targeted areas and encourage human economic and social activities in the surrounding areas, all of which will effectively contribute to sustainable development.

The project will also provide new foreign currency resources for Tunisia and thus improve the profitably of the waste sector. This will ensure high standard practices in waste management in Tunisia, and thus contribute to sustainable development.

Figure 1: Front view of Cell n° 3 of Djebel Chekir in 2005

A.3. Project participants:

Name of Party involved (*):	Private and/or public entity(ies) Project Participants(*)	Does the Party involved wish to be considered as project participant?
Government of Tunisia (Host Party)	Agence Nationale de Gestion des Déchets (ANGED-Tunisia-Host Party) – Project Proponent-Public	No
Government of Italy	International Bank for Reconstruction and Development (IBRD) as the Trustee of the Italian Carbon Fund (ICF)	Yes

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Tunisia

A.4.1.2. Region/State/Province:

Greater Tunis

A.4.1.3. City/Town/Community:

Tunis

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity

The Djebel Chekir landfill is located at about 15 km, West part of Tunis Capital, North-East of Tunisia. The landfill is currently the only landfill that receives the whole Municipal Waste of the four Governorates of Greater Tunis Capital: Tunis, Ariana, Ben Arous and Manouba.

The landfill site can be reached from Tunis City through Beja Direction, and is located at about 3 km from the main road in a rural area called El Attar.

The whole Djebel Chekir site has an area of 124 hectares. The landfill has been implemented sequentially, cell by cell. Three cells have been put into operation so far, totalizing 23 ha. Cell 1 (8 ha) has been operated from May 1999 to September 2001, and contains 1.17 Million tons of solid wastes. Cell 2 (8 ha) has been operated from October 2001 to September 2003, and contains approximately 1.23 Million tons of solid wastes. Cell 3 (7 ha) has been operated since October 2003 and its life time is being extended up to June 2006, with a final expected quantity of 1.87 Million tons of landfilled wastes. At the projected closure date of Cell 3 in June 2006, the three cells of the landfill would have received a total of 4.27 Million tons of solid wastes.

Two additional cells (4 and 5) covering 10 hectares each, will be put into operation sequentially after the closure of the Cell 3 in June 2006. During the remaining useful life of the landfill, cells 4 and 5 will be receiving approximately 3.15 Million tons of wastes up to end of year 2010.

At that date, a total of 7.42 Million tons of solid wastes would have been landfilled at the Djebel Chekir landfill. Detailed data are listed in Section B.2, table 4.

Figure 3: Geographical Location of Djebel Chekir landfill (Tunisia)

A.4.2. Category(ies) of project activity:

Sectoral scope 13- Waste handling and disposal

A.4.3. Technology to be employed by the project activity:

The purpose of the project is to implement an efficient gas recovery and flaring system in Djebel Chekir landfill, as to generate Certified Emission Reductions.

- **The LFG System of the project activity**

The extraction, collection and destruction of LFG would require three main components:

LFG vertical extraction wells

- Drill and build 4 LFG extraction wells/ha (50 meter distance between well centerlines) with a nominal well diameter of 600 mm
- In each well, install a high density polyethylene perforated pipe (minimum of 150 – 160 mm in diameter) to receive and transmit the LFG to the surface
- Fill the space surrounding the perforated pipe with clean crushed stones or gravel of 19 – 80 mm size.
- All wells will be equipped with wellheads to enable monitoring of quantity and quality of the LFG, and with valves to allow for an appropriate adjustment of the vacuum of each well.

Intermediary piping system to convey the LFG from the wells, to the primary collection pipes

- Dig trenches and install buried high density polyethylene collection piping system, to convey the LFG from the wells to primary collection pipes
- Install a high density polyethylene collection piping system, to convey the collected LFG to the blower/flaring station

Flaring Equipment

- Establish a flaring installation equipped with a blower, a De-condensation equipment, a flare, and all the monitoring and measuring soft and hardware.
- According to the CH4 flow estimates, the maximum flaring capacity would be reached by 2010-2011 with around 7,000 Nm3/hour of LFG to be burned.

In addition, a horizontal drainage network for leachate in Cells 1, 2 and 3 will be necessary to appropriately operate the LFG system. However, the leachate drainage system will be designed, installed, operated and maintained as a part of the overall responsibilities of the landfill operator and not the LFG contractor.

- **Activities to be launched by the project activity**

To allow for an appropriate LFG extraction and flaring, starting from January 2007, the project should undertake the following activities, targeting the 3 filled Cells and the 2 projected ones:

Existing Cells 1, 2 and 3

- Install appropriate leachate drainage to meet the minimum requirements to optimize LFG collection. This activity is to be fully covered by the landfill operator.
- Build the necessary wells in the 3 existing cells, in such a way that we would have a total of 92 operating wells (4 wells per ha) to enable for an appropriate gas collection.
- Design and install the LFG system to collect and flare methane for Cells 1, 2 and 3.

Projected Cells 4 and 5

- Design and Implement an appropriate LFG system to collect and flare methane for Cells 4 and 5.

The whole landfill

- Put in place a formal Operational Guide to enable for the optimization of the LFG extraction and flaring.
- Undertake a training program targeting ANGED staff involved in LFG contract management.
- Design and implement an appropriate monitoring and measuring system of the LFG for the whole landfill.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances

Solid waste management regulations in Tunisia do not require the recovery and destruction of CH4 from landfills. There are currently 5 controlled landfills in Tunisia, Djebel Chekir and

four other small landfills. None of them includes or projects to install LFG systems.

One exception relates to Henchir Lihoudia, one of the largest open dumpsites in Greater Tunis. Several years after the closure of this dump, it was decided to rehabilitate it as exploit it for various social and recreational activities (public park, museum), for the benefit of the surrounding poor communities.

During rehabilitation activities, site investigations have been conducted and the conclusions were the existence of two minor gas pockets that might affect the safety use of the site. Therefore, decision has been taken to install limited gas wells with the necessary flaring equipment. In fact, several months after the implementation of the flaring equipment, actual data of flared gas reveals minor quantities of CH4 still remaining in the dump, which suggest major part of CH4 was partly burned due self ignition and burning of waste practices and partly emitted into the atmosphere during the operational life of the dump.

Regarding Djebel Chekir landfill, previous contractual arrangements with landfill operators have included clauses for LFG recovery and destruction for safety purposes. However, due to various reasons (see section A.2), these clauses have never been applied, and the wells were damaged due to inappropriate maintenance, after some unsuccessful attempts to use them. Therefore, all CH4 that is generated is emitted into the atmosphere.

Due to unsuccessful experience in Cell 1, the other operating cells (2 and 3) did not have LFG recovery system put in place.

Overall, the entire site is developed using appropriate specifications except for leachate recovery in Cell 1 and part of Cell 2 and the initial safety wells.

The new contractual clauses for Djebel Chekir do not request the new landfill operator to install any LFG recovery system.

It is not likely that economic, technical, regulatory or other types of incentives will be adopted in the foreseeable future that could significantly change the current practices. In fact, there is no economic rationale, for Tunisia, to invest in LFG collection and flaring system, as the limited resources should be allocated to priority needs such as replacing dumps with managed landfills, and closing and rehabilitating existing dumps as well as the surrounding areas.

Taking the national circumstances into account, there will unlikely be any serious macroeconomic or microeconomic incentives in the future, to promote LFG extraction and destruction, and thus, significant quantities of CH4 would have been emitted into the atmosphere over the whole "active" period of the landfills, in the absence of the CDM project activity.

The implementation of an appropriate LFG extraction system will therefore allow LFG recovery and flaring to CO2, which would contribute to dramatically reduce GHG emissions into the atmosphere, as compared to the baseline situation.

A.4.4.1 Estimated amount of emission reductions over the chosen crediting period:

Years	Annual estimation of emission reductions in tonnes of CO_2 e
2007	334 131
2008	369 346
2009	401 209
2010	430 040
2011	456 128
2012	412 669
2013	373 346
2014	337 765
2015	305 571
2016	276 439
Total estimated reductions (tonnes of CO2 e)	**3 696 644**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2 e)	**369 664**

A.4.5. Public funding of the project activity:

No public funding is involved in this project.

SECTION B. Application of a baseline methodology

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

"Consolidated baseline methodology for landfill gas project activities – ACM0001/Version2, 30 September 2005"

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

Project activity meets applicability criteria of the chosen methodology. This methodology is adopted in relation with the selected approach for baseline taken from paragraph 48 of the CDM modalities and procedures: "(b) Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment". The baseline scenario in Djebel Chekir landfill does not consider any LFG system, and leads to a total atmospheric release of the landfill gas. The project activity includes the situation where the LFG is captured and flared, assuming a realistic collection and destruction efficiency.

B.2. Description of how the methodology is applied in the context of the project activity:

According to the Consolidated Baseline Methodology ACM0001, the greenhouse gas emission reduction achieved by the project activity during a given year "y" (ER_y) is the difference between the amount of methane actually destroyed/combusted during the year ($MD_{project,y}$) and the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{reg,y}$), times the approved Global Warming Potential value for methane (GWP_{CH4}), plus the net quantity of electricity displaced during the year (EG_y) multiplied by the CO2 emissions intensity of the electricity displaced ($CEF_{electricity,y}$), plus the quantity of thermal energy displaced during the year (ET_y) multiplied by the CO2 emissions intensity of the thermal energy displaced ($CEF_{thermal,y}$).

In the case of Djebel Chekir, no Electricity generation will be considered. Therefore, the emission reduction will be calculated as follows:

$$ER_y = (MD_{project,y} - M_{dreg,y}) * GWP_{CH4}$$

There is no regulation requiring recovery and flaring of any amount of LFG in the landfills in Tunisia. Moreover, in the case of Djebel Chekir, there was not CH4 recovery and flaring in the past, and the new bid for operating the landfill does not commit the landfill contractor to recover and flare LFG. Therefore, the baseline will consider all the CH4 potential as emitted into the atmosphere, based on the IPCC methodology for estimating these emissions.

- **Estimation of Methane to be Generated From landfill**

The first step in applying the methodology is to estimate the volume of methane that is expected to be generated from the landfill during the project lifetime. This estimated quantity of methane is based on the amount of waste that has been landfilled so far in Cells 1, 2 and 3 since the opening of the landfill in 1999, and on the projected quantity of waste to be disposed of in the Cells 4 and 5 according to the quantities specified in the coming contract between ANGED and the new contractor.

The first order decay model[1] as described in the Revised 1996 IPCCC Methodology was used to estimate methane emissions from the landfill. The model is as follows:

$$CH4_{Projected,\ y} = k * L_o * \sum_{t=0,y} WASTE_{contract,\ t} * e^{-k(t-y)}$$

Where:

$CH4_{projected,y}$: the quantity of methane projected to be generated (m^3)

k : the methane generation rate constant (1/yr) relates to the time taken for the Degradable Organic Carbon (DOC) in waste to decay to half its initial mass.

L_o : the methane generation potential (t CH4 / t Waste)

$Waste_{contract,t}$: the waste input at year y

y : the year where the waste was input to the landfill

t : the year where methane emission is estimated for the waste deposited in year y

♦ ***Assumption of k***

According to IPCC guidelines, the value of the methane generation rate constant may range from 0.005 to 0.4 per year. The estimation of methane generated form the landfill is highly sensitive to the assumption of the value of k.

k value depend on the moisture content in the landfill, temperature in the anaerobic zone, pH , and nutrient availability.

The most rapid rates (k = 0.2 or a half life of about 3 years) are associated with high moisture conditions and rapidly degradable material such as food waste. The lower decay rates (k = 0.03 or a half life of about 23 years) are associated with dry conditions and slowly degradable waste such as wood or paper. The Tunisian conditions are quite favorable to biodegradation kinetic because of the high temperature, moisture content and humidity conditions and the high composition in rapidly degradable materials such as food waste (60%). Despite these favorable conditions, a conservative k value of 0.1 is adopted (or a half life of about 7 years).

♦ ***Estimation of Methane Generation Potential (Lo)***

According to IPCC guidelines, methane generation potential (t CH4 / t Waste) is estimated

[1] See USEPA Manual "Turning a Liability into an asset: A landfill gas to energy Handbook for Landfill Owners and Operators" (December 1994).

using the following equation:

$$Lo = MCF*DOC*DOC_f*F*(16/12)$$

Where:

MCF: the methane correction factor

DOC: the degradable organic carbon in the waste (fraction)

DOCf : the fraction of organic carbon dissimilated (fraction)

F : the fraction by volume of CH4 in the landfill gas (fraction)

16/12 : Conversion from C to CH4

Estimating MCF

According to IPCC, MCF is assumed according to the types of sites shown in Table 1.

Table 1: Methane Correction Factor (MCF)

Type of Site	Methane Correction Factor (MCF)
Managed landfill	1
Unmanaged – deep (≥ 5m waste)	0.8
Unmanaged – shallow (< 5m waste)	0.4
Default value – uncategorized SWDSs	0.6

MCF was assumed to have a value of 1 since the landfill is a well managed and controlled landfill. According to IPCC guidelines, well managed landfills should have controlled placement of waste and a degree of control of scavenging activities and control of fires should be in place. Overall, the Djebel Chekir landfill satisfies these criteria for the following reasons:

- Placement of waste is well planned in previously designed cells;
- The bottom of the whole landfill is made of a deep non-porous clay;
- After the placement of each 2 m-layer of waste, the waste layer is cover by a 30 cm sand layer which help better compaction and leveling of the waste and prevents any human interference with waste as well as possible self ignition..
- The landfill is protected with a fence that surrounds it from all sides and no scavenging activities are allowed inside the landfill.

Estimating DOC

Degradable organic fraction is based on the composition of the waste. DOC is estimated from a weighted average of the carbon content of various components of the waste stream. Table 6-3 of the Revised 1996 IPCC guidelines gives default values for the carbon content for various waste types. These values are presented in Table 2, shown below.

Table 2: Degradable Organic Carbon For Major Waste Streams

Waste Stream	Percent DOC by Weight
A. Paper and textiles	40%
B. Garden and park waste, and other (non-food) organic putrescibles	17%
C. Food wastes	15%
D. Wood and straw waste	30%

In case the percentage of each type of waste in the total waste stream is known, the weighted average of the degradable organic carbon can be estimated as follows:[2]

% DOC (by weight) = 0.4(A) + 0.17(B) + 0.15(C) + 0.3(D)

Where:

A: Percent paper and textiles in the waste

B: Percent garden and park waste, and other non-food organics

C: Percent food waste

D: Percent wood and straw waste

Table 3, shown below, presents the composition of waste in Tunisia. This composition was used to estimate the degradable organic fraction of the Tunisian waste. In addition, relevant correction factors were used for lignin when calculating DOC (Lignin proportion subtracted).

Table 3: Organic Materials subject to decomposition that are contained in the Tunisian Waste

	Waste composition
Paper and textiles	11.0%
Garden and park waste and other (non food) organic putrescibles	5.63%
Food waste	60.26%
Wood and straw waste	0.04%
Total	**76,9%**

The calculated DOC for the Djebel Chekir would be the following:

[2] Equation 2 of the Revised 1996 IPCC guidelines, p. 6.9.

% DOC = 0.4 x (0.11) + 0.17 x (0.0563) + 0.15 x (0.6026) + 0.3 x (0.0004) = 0.14

Estimating DOC_f

Fraction dissimilated DOC is the portion of the degradable organic carbon that is converted to landfill gas. IPCC guidelines present the following equation to estimate DOC_f:

$DOC_f = 0.014T + 0.28$

T, the temperature in the anaerobic zone was assumed at 35 ^oC. Therefore, the DOC_f was estimated as follows:

$DOC_f = 0.014(35) + 0.28 = 0.77$

According to the IPCC Good Practice Guidance, this default factor of DOC_f should be used only if the lignin C is excluded from the DOC Value. Since this has been applied for the current DOC calculation, 0.77 is an appropriate number for Djebel Chekir.

Estimating F

The default value for the fraction of methane in landfill gas is 0.5 as given by IPCC.

Estimating L_o

Based on the estimation of different parameters calculated above, methane generation potential is estimated as follows:

$Lo = MCF*DOC*DOC_f*F*(16/12)$

Lo = 1*0.14*0.77*0.5*(16/12) = 0.072 T CH4 / t Waste (approximately 100 m3 CH4 / Mg Waste)

IPCC guidelines states that the value of Lo may range from less than 100 to over 200 m3 CH4 / t Waste (i.e. 0.072 to 0.143 t of CH4/ton of wastes using a standard density of 0.72). This shows that the estimated value for Djebel Chekir is equal to the lowest value of the range.

- ***Estimation of Waste Quantities***

Daily data on wastes received are accurately archived at Djebel Chekir Offices on site, by SOMAGED, the private landfill operator, and in parallel by both the Exploitation and the Financial and Administrative Departments of ANGED. The quantity of waste landfilled is accurately recorded since this determines the amount of invoice to be issued by SOMAGED for payment by ANGED.

Historical quantities of waste are taken from the recorded statistics of the Financial and Administrative Department of ANGED.

Projected yearly amounts of waste (700,000 tons) to be disposed at Djebel Chekir for the period 2006-2010 are mentioned in the international bidding document (see page 7 of the CAHIER DES CLAUSES TECHNIQUES PARTICULIERES -CCTP), of Djebel Chekir that was released for the selection of the new landfill operator. The projected amount will also be

mentioned in the contractual arrangements with the new operator, once it is selected (by end of March 2006).

Table 4 presents the official historical and projected waste stream in Djebel Chekir:

Table 4. Historical and projected waste stream in Djebel Chekir

Year	Waste Quantity (Tons)
1999	221 815
2000	476 657
2001	622 264
2002	604 295
2003	628 503
2004	690 638
2005	672 004
2006	700 000
2007	700 000
2008	700 000
2009	700 000
2010	700 000

- ***Total Quantity of Methane Generated***

Applying the IPCC model using the estimated parameters, the total quantity of methane generated from the landfill can be estimated. Figures 4, below, presents in tons, the total quantities of methane that are expected to be generated from Djebel Chekir, during almost the whole "active" period of the landfill in terms of CH4 generation (1999 to 2032).

Figure 5 shows quantities of methane generated since the launching of the landfill, and to be generated in the baseline situation within the period 2000-2016, expressed in tCO2 equivalent.

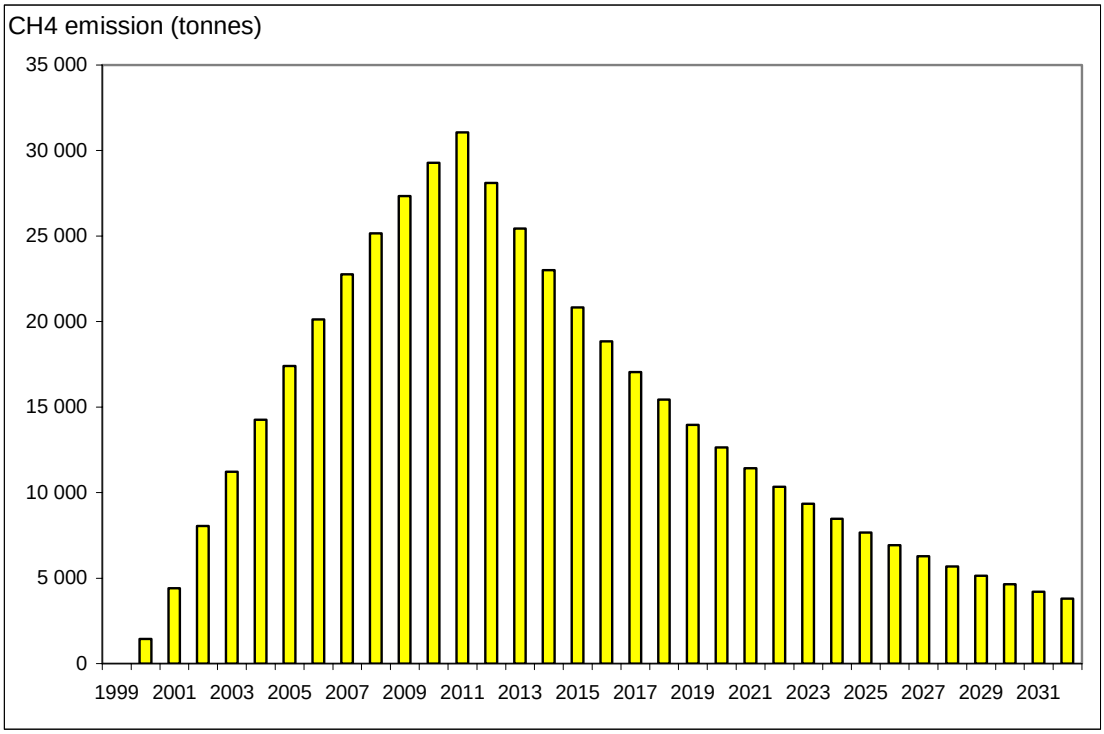

Figure 4: Historical and projected methane generation from Djebel Chekir landfill for the period 1999-2032 (t CH4)

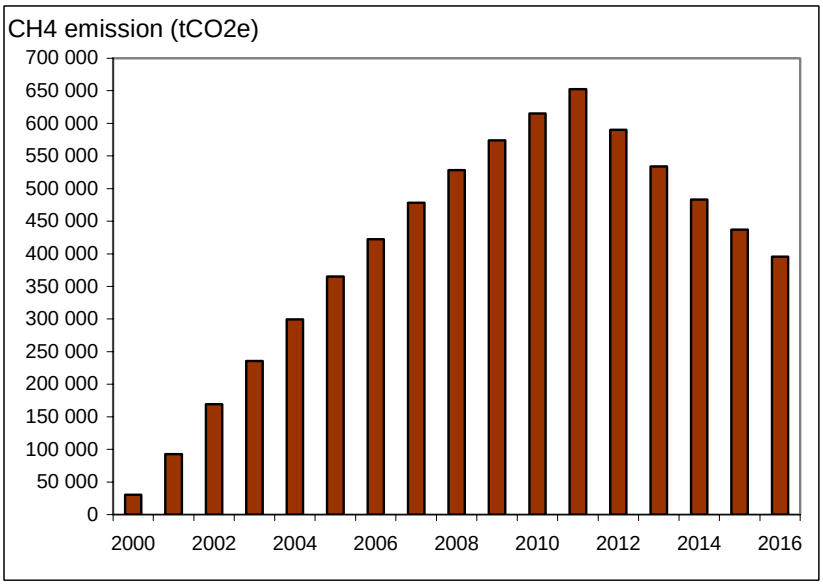

Figure 5: Projected methane generation from Djebel Chekir landfill in the baseline situation (tCO2 equivalent)

♦ ***Estimation of Baseline Emissions***

As stated in the consolidated baseline methodology ACM0001, baseline emissions should be calculated from the above estimates, while applying the mandated regulatory or contractual fraction to be flared if any.

According to the future contractual arrangements to be made, baseline situation does not consider any proportion of the LFG to be flared for Djebel Chekir.

Overall, the estimated baseline emissions will amount to **5,288,763** tonnes of CO2e over the 10 years of the prescribed crediting period.

Estimated yearly baseline emissions are shown in table 5, Section E.4.

B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

This section describes how the anthropogenic emissions of greenhouse gases by the source (the landfill) are reduced below those that would have occurred in the absence of the registered CDM project activity. The determination of Djebel Chekir landfill gas capture project scenario additionality is done using the CDM consolidated "Tool for the demonstration and assessment of additionality", which follows five steps. The purpose of the additionality tool is to check that the claim of additionality is justified and to ensure that baseline activities do not receive CERs.

Demonstration of additionality

The additionality tool is used in conjunction with the consolidated methodology ACM0001.

The following steps from the "tool for the demonstration and assessment of additionality" will be applied:

Step 0 - Preliminary screening based on the starting date of the project activity

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

Step 2 - Investment Analysis

Step 3 – Barrier analysis

Step 4 - Common Practice Analysis

Step 5 - Impact of CDM Registration

Step 0 - Preliminary screening based on the starting date of the project activity

The project will start by January 2007, so the registration will occur before the start of the first crediting period.

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

♦ ***Definition of alternatives to the project activity:***

In order to estimate the attractiveness of the project activity, two other credible alternatives that provide outputs or services comparable with the proposed CDM project activity are considered.

Alternative 1: Continuation of current practice which means the waste will continue to be disposed off in a controlled landfill without collecting and flaring landfill gas.

Alternative 2: The proposed project activity (LFG collection and flaring) is implemented for security purposes but not considered as a CDM project activity.

An additional a**lternative** might also be considered: the LFG from Djebel Chekir landfill is recovered and used for electricity generation. However, besides its higher emission reductions and safety this alternative provides a significantly different service i.e. the power to be exported to the grid. It also implies a much higher level of financial and technical risks. As power generator at MSW is a delicate and complicated process and given the lack of experience in managing such utility in Tunisia, the technical and, thus, financial risks related to the installation of a power generator are very high at this moment.

♦ ***Enforcement of applicable laws and regulations:***

As mentioned below, there is no mandatory law or regulation that forces the landfill operators to collect and flare methane or to use it in generating electricity. Therefore, all three alternatives are in compliance with all applicable legal and regulatory requirements.

In addition, in the foreseeable future, it is unlikely that new regulations or laws that may bring one of these projects to non-compliance would be issued. Moreover, and according to the monitoring plan ACM0001, relevant regulations for LFG extraction or combustion (even if these laws and regulations have objectives other than GHG reductions) will be monitored yearly, and any implication on emissions should be taken into account when calculating actual emissions of the project activity.

Step 2 - Investment Analysis

Sub-step 2a: Determine appropriate analysis method:

According to the methodology for determination of additionality, if the CDM project activity generates no financial or economic benefits other than CDM related income, then Option I must be used. As this is the case for the project, option I is applied here.

Sub-step 2b: Option I. Application of simple cost analysis

Alternative 1 doesn't imply any investment and it the most workable option for Tunisia.

The total investment of the LFG collection and flaring system in Djebel Chekir landfill is

estimated at 4.6 MUS$, which will be mobilized through a World Bank Loan. The LFG system will also imply various other expenses over the whole project period to operate, maintain the equipments, and cover other project activity-related expenses (including administrative expenses and interest rate-related expenses). Considering alternative 2, i.e. an LFG project without CDM, the project would not have been adopted by Tunisia as it wouldn't generate any revenue, and its Net Present Value would be substantially negative (MUS$ -4.9), with an IRR also negative.

The total investment to equip Djebel Chekir landfill with LFG collection and power generator will require much higher investment amounts. Assuming a minimum of 10 MW power generator, the investment cost for such project would be MUS$ 14 including LFG collection and possibly the need to enhance the electrical line to export the electricity to the grid. Thus, it implies a 2.5 times higher investment cost than the selected project activity which is beyond the financial Tunisian capacity for such project. Moreover, taking into account the current selling price of electricity (0.37 US Cts), and the complex regulatory circumstances for power generation the feasibility of electricity generation could not be considered as a baseline.

Therefore, there is no economic rationale, for Tunisia, to invest neither in LFG collecting and flaring systems nor in LFG recovery and use for power generation, as limited resources available should be allocated to priority needs such as replacing dumps with managed landfills, and rehabilitating these dumps as well as the affected surrounding areas.

Given that, the only remaining plausible baseline scenario is Alternative1.

Step 3 - Barrier Analysis

Step 2 is completed, this Step is therefore skipped.

Step 4 - Common Practice Analysis

Djebel Chekir was the first controlled landfill of its kind in Tunisia. However, four other small controlled landfills have been established since 1999. None of these landfills have been equipped with LFG and flaring systems.

Moreover, the next 9 landfills that will be operated in 2006 have not been equipped with such a system, and the current contracts that are being prepared for the future landfill contractors are not considering any LFG management mandates. It is unlikely that LFG systems would be prevalent in the future without the CDM contribution. Common Practice for Controlled landfills doesn't consider CH4 extraction and flaring. The only case where a LFG system was seriously considered relates to the previously closed dump of Henchir Lihoudia which is being equipped with LFG wells and flaring equipment, i.e. a years after its closure. The dumpsite has been closed since 1999 and being used as an urban park for recreational purposes. Recently, some specific parts of the site have been identified with potential safety risks and thus limited CH4 extraction and flaring activities are underway for safety of the site.

Step 5 - Impact of CDM Registration

The project activity will generate significant economic benefits through the sale of ERs that will justify contracting a loan to cover the investment expenses and to make project implementation possible.

Description of the baseline scenario: When applying common practice, which assumes a continuation of current practice with wastes being disposed off in a controlled landfill without collecting and flaring landfill, a total release of **5.3** MtCO2e would have been emitted into the atmosphere, over the whole project period (January 2007- December 2016).

Description of the project activity scenario: In the project activity situation, wastes will be disposed off in the same controlled landfill but will consider the implementation of a full collection and flaring system. Assuming a conservative **70%** recovery-destruction rate, emissions within the project activity would only totalize **1.59** MtCO2e including induced emissions due to electricity consumption from the grid to operate the whole LFG system, and thus would avoid **3.7** MtCO2e from being emitted into the atmosphere.

Reason why emissions in the project activity are lower than those generated in the baseline scenario: In the project activity situation, CH4 is fully oxidized as it is, involving the use of a 21 GWP. The project activity will allow to flare the CH4, and thus to generate CO2 instead, which GWP is equal 1. In addition, CO2 emissions are not accounted for in the emission balance, due to the biogenic origin of this CO2.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

The project boundary related to the baseline is the physical boundary of the whole landfill. Emissions calculated in the baseline are methane emissions form the Djebel Chekir landfill within its boundary. In principal, the landfill emissions during project activity occur within the same boundary as the one related to the baseline. However the LFG collection and flaring system will also imply a consumption of some quantities of electricity from the grid.

Such emissions are not that significant, but for completeness purposes they have been estimated and reflected in emissions related to the project activity.

Electrical consumption for LFG system is based on a 100 KW nominal capacity for flaring, which meet the peek flow of LFG in Djebel Chekir, taking the requirement of existing technologies into account, plus a 30% overestimation of capacity which will reflect some conservativeness expressed in terms of m3/hr. A full time functioning; e.g. 8760 hours are also assumed, which is overestimated.

In estimating emissions, the last five-year's emission average at Power Company STEG (Ref. Emission report for energy sector for the period 1990-2003 in Tunisia) in terms of tCO2e per MWh has been considered, with the transport and distribution losses (12%) added to this

average emission indicator. Thus, emission factor for electricity in Tunisia is 0.627 tCO2e/MWh delivered, taking into consideration that the electricity generation is mainly based on natural gas in Tunisia.

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

Date of Completion: 20/11/2005
Name of Person Determining Baseline: Dr Samir Amous. He is not a project participant.
Email: amous.apex@gnet.tn

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:

The starting date of the project activity is expected to be 1st January 2007.

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

11 years.

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

C.2.1. Renewable crediting period

N/A

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

C.2.1.2. Length of the first crediting period:

C.2.2. Fixed crediting period:

A ten-year fixed crediting period will be used for this project.

C.2.2.1. Starting date:

01/01/2007

C.2.2.2. Length:

10 years.

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

"Consolidated Monitoring methodology for landfill Gas Project activities – ACM0001- Version 02".

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

In conjunction with the consolidated baseline Methodology, this consolidated monitoring methodology is applicable for the Djebel Chekir project activity since the project reduces greenhouse gas emissions through landfill gas capture and flaring where the baseline is established by a public concession contract.

The Monitoring Methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform, in the project activity, as shown below.

The Monitoring plan provides for continuous measurement of the quantity and quality of LFG flared in the project activity. The main variables that need to be determined are:

- the quantity of methane actually captured ($MD_{project,y}$)
- the quantity of methane flared ($MD_{flared,y}$)

To determine these variables, the following parameters have to be monitored:

- The amount of landfill gas generated (in m³, using a continuous flow meter), where the total quantity ($LFG_{total,y}$) as well as the quantities fed to the flare ($LFG_{flare,y}$) are measured continuously.
- The fraction of methane in the landfill gas ($w_{CH4,y}$) will be measured with a continuous analyzer.
- The flare efficiency (FE), measured as the fraction of time in which the gas is combusted in the flare multiplied by the efficiency of the flaring process. For this purpose, the methane content of the flare emissions will be analyzed monthly, to determine the fraction of methane destroyed within the flare.
- Temperature (T) and pressure (p) of the landfill gas.
- The quantities of electricity or any other fuels required to operate the landfill gas project, including the pumping equipment for the collection system
- Relevant regulations for LFG project activities will be monitored. Changes to regulation will be converted to the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{reg,y}$). The monitoring report will explain how regulations are translated into that amount of gas if any.

In addition the Monitoring Plan will continuously monitor the quantities of wastes received and landfilled in Djebel Chekir.

Monitoring of the electrical consumption (El) of the LFG equipment will also be made on

continuous basis, using an electrical meter.

The measurement equipment for gas quantity and quality (humidity, particulate, composition, etc.) will be subject to high QA/QC standards and to an appropriate calibration process.

Calibration procedures and schedule will be defined by the technology provider according to EU standards.

ANGED will establish a monitoring team that will ensure appropriate operation of the LFG system in Djebel Chekir. Monitoring of data provided by electronic equipments can be made through telephone connection (remote monitoring) and through field visits to be undertaken by ANGED LFG monitoring unit. ANGED can also mandate external experts as a part of its Auditing and Verification procedures.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

>> Option 1 is not applicable. Option 2: *Direct monitoring of emission reductions from the project activity* is applied.

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>> Not Applicable

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>> Not Applicable

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number	Data variable	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept	Comment
1 $MSW_{total,y}$	Total Quantiy of Waste Landfilled in year y	metric tonnes	m	Daily	100%	Monthly (e and p) and Annually	During the crediting period and two years after	Measured at weight bridge Copies of the bills issued by the Landfill operating company to the ANGED Data to be aggregated monthly and yearly
2 $LFG_{total,y}$	Total amount of landfill gas captured	m^3	m	Continuous	100%	Daily: e Monthly: p	During the crediting period and two years after	Measured by a flow meter. Data to be aggregated monthly and yearly
3 $LFG_{flare,y}$	Total amount of landfill gas flared	m^3	m	Continuous	100%	Daily: e Monthly: p	During the crediting period and two years after	Measured by a flow meter. Data to be aggregated monthly and yearly

4 FE	Flare/combustion efficiency, determined by the operation hours(1) and the methane content in the exhaust gas (2)	%	m/c	(1) Continousy (2) Monthly	n/a	Daily: e Monthly: p	During the crediting period and two years after	(1) Monthly measurement of methane content of flare exhaust gas (2) Continuous measurement of operation time of flare Data to be aggregated monthly and yearly
5 $w_{CH4,y}$	Methane fraction in the landfill gas	m^3 CH4/ m^3 LFG	m	Continuous	100%	Monthly: e & p	During the crediting period and two years after	Measured by a continuous gas quality analyzer Data to be aggregated monthly and yearly
6 T	Temperature of the landfill gas	°C	m	Continuous	100%	Monthly: e & p	During the crediting period and two years after	Measured to determine the density of the methane D_{CH4} Data to be aggregated monthly and yearly

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived (continued):								
ID number	Data variable	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept	Comment
7 p	Pressure of the landfill gas	Pa (in bars)	m	Continuous	100%	Monthly: e & p	During the crediting period and two years after	Measured to determine the density of the methane D_{CH4} Data to be aggregated monthly and yearly
8 El	Electricity consumption	El (in kWh)	(m)	Continuous	100%	Electronic and Paper	During the crediting period	Measured to determine off-site emissions due to electricity consumption of the project activity from the grid
9	Regulatory requirements related to landfill gas projects	Test	-	Annually	100%	Electronic and Paper	During the crediting period and two years after	Required for any changes to the adjustment Factor (AF) or directly $MD_{reg,y}$

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

>> **N/A**

D.2.3. Treatment of leakage in the monitoring plan

No leakage will be considered for the project activity

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

N/A

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO2 equ.)

Emission reduction should be calculated from the following equations:

$ER_y = (ER\_CH4_y * CF * GWP\_CH4) – (El_y * 0.627)$

$$ER\_CH4_y = CH4_{project,y} - CH4_{baseline,y}$$

Where:

ER_y is the GHG reduction in t $CO2_e$

ER_CH4_y is the methane emission reduction in m^3

CF is a conversion factor from m^3 CH4 to t CH4 (0.0007168) at standard temperature and pressure (0 degree Celsius and 1.013 bar)

GWP_CH4 is the global warming potential for CH4 (21)

$El_{y:}$ Is the annual electricity consumption of the LFG system.
0.627 is the emission indicator for electricity from the grid in Tunisia expressed in tCO2e/MWh.

$CH4_{project,y}$ is the monitored quantity of methane actually flared in the project in m^3

$CH4_{baseline,y}$ is the quantity of methane required to be flared under regulations, as calculated in section B adjusted by actual waste and actual % CH4 in LFG

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored			
Data	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data ?	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
2. $LFG_{total,y}$	Low	Yes	Flow meter will be subject to a quarterly maintenance and testing regime to ensure accuracy
3 $LFG_{flare,y}$	Low	Yes	Flow meter will be subject to a quarterly maintenance and testing regime to ensure accuracy
4. FE	Medium	Yes	Regular maintenance will ensure optimal operation of flares. Flare efficiency will be checked quarterly, with monthly checks if the efficiency shows significant deviations from previous values
5 $w_{CH4,y}$	Low	Yes	The gas analyser will be subject to a quarterly maintenance and testing regime to ensure accuracy

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

The project will follow the monitoring plan as described in annex 4.

D.5 Name of person/entity determining the monitoring methodology:

Dr. Samir Amous, APEX Conseil – amous.apex@gnet.tn

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions of the project activity by sources:

The destruction of methane in flares will lead to an almost complete conversion of the generated CH4 into CO2. The source of methane, which generates CO2 emissions when flared, is of biogenic origin, therefore, as stated by IPCC Good Practice Guidance, it is part of the natural organic CO2 cycle, and the generated CO2 should not be counted as net contributor to climate change.

There are only two potential sources of project emissions identified within the system boundary: the part of CH4 potential in the landfill that the project is assuming not to be able to collect and burn, and that might be considered as fugitive methane emissions from the landfill, and the off-site emissions due to the electricity consumption of the project activity. It has been assumed that the LFG system installed in Djebel Chekir will only be able to recover and flare a conservative rate of 70% of the whole CH4 landfill potential. Therefore 30% will have the potential to escape as fugitive emissions, and thus are considered as the reference point project activity emissions. In addition, off-site emissions due to electricity consumption of the LFG system will be accounted as a part of the project activity emissions.

The actual LFG recovery rate based on international experience can range from as low as 50 – 60% to as high as 85%. For the well-designed Djebel Chekir landfill 70% is considered a conservative estimate based on the characteristics of the waste deposited, the proper compaction of the waste deposited, the depth of the waste body, and the proper covering of the waste body during and after completion of waste deposition.

The direct emission source within the project boundary is the methane escaping capture and flaring plus some minor amounts of emissions due to electricity consumption of the LFG system. No other significant source of site emissions exists.

Overall, the directly estimated reference point emission within the project activity is calculated by multiplying baseline emissions by 30% plus emissions due to electricity consumption, and these will amount to 1,592,119 tonnes of CO2e over 10 years.

Estimated yearly amounts of fugitive gas potential, which reflect the reference point emission of the project activity, are shown in Section E.6.

E.2. Estimated leakage:

No Leakage effects need to be accounted under the consolidated methodology.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

Estimated emissions from the project activity will amount to 1,592,119 tonnes of CO2e over 10 years, in which 5,490 tCO2e are due to electricity consumption of the LFG system and 1,586,629 tCO2e are emitted within the landfill as a result of incomplete collection and destruction (30%) of the LFG potential in the landfill.

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

Estimated emissions due to the baseline will amount to **5,288,763** tonnes of CO2e over 10 years as shown in section E.6.

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

During operations, actual emission reductions will be calculated from the accurately measured CH4 being flared minus emissions due to electricity consumption of the LFG equipment. Project emissions can only be estimated by assuming the efficiency of collection of the LFG. The conservative efficiency of the collection and flaring system for Djebel Chekir is assumed to be 70%.

Estimated emissions reductions due to the project activity will amount to 3,696,644 tonnes of CO2e over 10 years.

E.6. Table providing values obtained when applying formulae above:

Years	Estimation of project activity emissions (tonnes of CO_2 e)	Estimation of baseline emissions (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2 e)	Estimation of emission reductions (tonnes of CO_2 e)
2007	143 983	478 114	0	334 131
2008	159 075	528 421	0	369 346
2009	172 731	573 940	0	401 209
2010	185 087	615 127	0	430 040
2011	196 268	652 395	0	456 128
2012	177 642	590 312	0	412 669
2013	160 790	534 136	0	373 346
2014	145 541	483 306	0	337 765
2015	131 743	437 314	0	305 571
2016	119 258	395 698	0	276 439
Total (tonnes of CO_2 e)	**1 592 119**	**5 288 763**	**0**	**3 696 644**

Figure 6 depicts the CO2 equivalent emissions in the baseline situation and within the project activity.

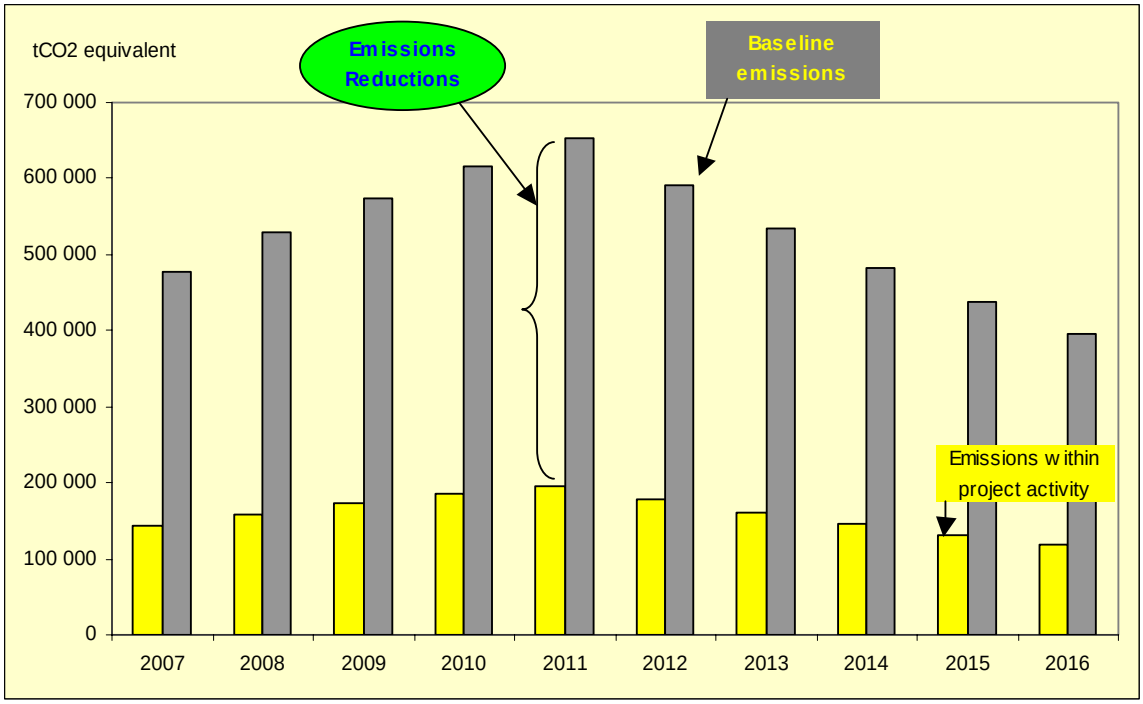

Figure 6: Estimated Carbon Dioxide Equivalent Emissions (baseline and project activity) (tCO2e)

SECTION F. Environmental impacts

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

Djebel Chekir Landfill was implemented in 1999, and all regulatory requirements were met at this time, including Environmental Impact Assessment as per Tunisian Regulations.

As regards to the CDM project, it should be noted that it is a part of a larger programme aimed at improving the overall waste management in Tunisia. The World Bank will provide to the government of Tunisia with a loan to partially finance a Solid Waste Management Project to support the implementation of this programme. According to the World Bank rules regarding the Environmental Impact Assessment, it has been requested to update the Environmental Impact Assessment as to better reflect the new landfill components (in addition of Cell 4 and Cell 5, and implementation of a LFG system).

In the baseline situation, Landfill gas is generated as a result of decomposition of municipal waste under anaerobic conditions. It is mainly composed of carbon dioxide and methane. Carbon dioxide and methane are greenhouse gases, which do not cause harmful effects to the local environment, but rather affect global warming and economic value of the area where the landfill is implemented.

In the baseline situation, emissions of methane from the landfill are associated with the following negative impacts:

- Undesirable odour especially for the human establishments surrounding the landfill area.
- Safety and health risks to landfills staff due to generation of methane concentration above safe limits as well as explosions and fires at the landfill site.

A very small percentage of volatile organic compounds (VOCs) is also found in the landfill gas, contributing to the undesirable odour. VOCs emissions are photochemically reactive, and result in the formation of tropospheric ozone. The latter might cause adverse effects to the respiratory system such as breathing difficulty and aggravated Asthma, and damages to crops and plants. VOCs are also known for their toxicity and carcinogenic effect from chronic exposure. However, since volatile organic compounds comprise very small percentage of the landfill gas, impact on air quality is expected to be minimal.

Overall, **the project activity** leads to positive environmental impacts which contribute to the sustainable development of the area and no significant negative impacts are expected.

The risk from collecting, pumping and treatment of landfill gas can be properly controlled. Controls from such operations include equipment safety precautions (such as alarms, safety valves, and automatic shutdown), daily inspection, and fire fighting extinguishers.

In the project activity, flaring of the collected biogas will destroy methane and thus will mitigate the above mentioned negative impacts.

Methane is a greenhouse gases, known for its contribution to global warming. The proposed project main activity is combusting the landfill gas to convert methane to carbon dioxide. Therefore, the project will result in positive environmental impacts where it will lead to decrease the amount of greenhouse gases released to the atmosphere.

While the LFG system will minimize explosion risks from methane emissions within the whole landfill site, there are obviously some risks associated with the operation of the flare, similar to any other industrial risks involving a source of fire. Conservative actions aimed at mitigating the risks are mentioned in section F.2 below.

The LFG system might also lead to some minor CO, NOx and VOCs emissions. However, thanks to the sophisticated combustion and to the high burning temperature (over 1000°C), it will ensure an almost total destruction of the gases. In that way, emission of CO, NOx and VOCs and other compounds present in the biogas such as ammonia will be minimal, and much lower anyway to what it would have been occurred in the absence of eh project activity.

Overall, the minimum required 10 m-height chimney will ensure for all emitted gases to be properly evacuated and dissolved into the atmosphere, with very limited impacts in the surrounding local environment and population.

F.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:

An update of the environmental impact assessment of Djebel Chekir landfill has been carried out. It shows not significant negative impacts from the project activities.

Locally, the capture and destruction of the major part of the LFG generated in Djebel Chekir landfill through the proposed CDM project will help improve the ambient air quality in the project vicinity areas. It will also help reduce impacts on water and environmental resources through an enhanced and environmentally acceptable leachate management system. Meanwhile, flaring the captured gas will not only destroy methane, but will also destroy compounds in the LFG such as volatile organic compounds and ammonia. The project will also mitigate number of risks associated with LFG gas at uncontrolled landfills such as: risk explosion, risk of fire, odours nuisances, potential local air quality deterioration, etc.

As confirmed by the Environmental Impact Assessment update, the quantities of CO, NOx and VOCs are insignificant, and far to be so important than the CH4 emissions in the baseline case. Therefore, no significant negative impacts are expected from the project.

There are minor risks from collecting, pumping and treatment of landfill gas. Moreover, they can be drastically controlled and mitigated. The mitigation of these minor risks lies on the types and standards of the technologies that will be selected to operate the whole LFG system, and particularly the flares.

To mitigate risks of fires and explosion, the proposed flares will be made of stainless steel furnaces with internal fireproof concrete protection. The internal flare tubes will be made also of stainless steel protected by ceramic fibbers equipped with a tube flange for exhaust sample analysis. The proposed flares will be equipped with flare and temperature control equipments. The temperature will be regulated by air intake control equipments. Also in terms of minimizing the explosion risks, the

proposed flares will be equipped with fully automatic controllers, automatic emergency switches and alarms. The flares will also be equipped with the following: • Manual and automatic on/off switch; • Lightening arrestor; • Flame temperature alarm; • Landfill gas temperature alarm; • Gas flow and temperature regulators; • External emergency switch; • UV radiation detection cells for flame control.

At global level, Greenhouse gas emission reductions will result from the efficient combustion of the recovered methane contained in the landfill gas. It is estimated that this project will generate 3.7 million of emission reductions within a 10-year period (January 2007- December 2016).

Capturing and destroying this methane is an efficient and significant contribution to mitigate climate change.

SECTION G. Stakeholders' comments

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

A public consultation meeting was held on 15 Feb 2006 in Tunis addressing the new CDM project of Djebel Chekir and the 9 other landfills.

A meeting report "Procès-Verbal" will be made available both at the ANGED and World Bank web sites including the list of participants.

The meeting was introduced by the Minister of Environment and Sustainable Development of Tunisia. The presentations covered various topics in relation with the two CDM projects:

- The Kyoto Protocol and CDM, their operating approaches and their contribution to financing Sustainable Development.
- Presentation of the two CDM projects of Djebel Chekir and the 9 landfills.
- Update of the Environment Impact Assessment of Djebel Chekir and the 9 landfills.
- Environmental management of Kairouan, Bizerte, Djerba, Gabes and Sousse landfills.

About 115 persons have attended this meeting. Participants include the major stakeholders and institutions directly involved in Waste Management and Environment Protection:

- Representatives from the Ministry of Environment and Sustainable Development (MEDD)
- Representatives from the Ministry of Interior
- Representatives from the Ministry of Development and International Cooperation
- Representatives from the Ministry of Health
- Representatives from the Ministry of Agriculture
- Representatives from the Ministry of Education
- Representatives from the National Waste Management Agency (ANGED).
- Representatives from the National Environment Protection Agency (ANPE).
- Representatives from NGOs involved in national and regional activities.
- Representatives from academic institutions.
- Representatives from Governorates (Ben Arous, Bizerte, Kairouan, Ariana, Medenine, Midoun Jerba, Monastir, Sfax, Sousse, Tunis),
- Representatives from Municipalities and Communes (Sousse, Medenine, Ariana, Bizerte, Hammamet, Sfax, Nabeul)

- Representatives from Cooperation Institutions and Donors (The World Bank, GTZ-Germany, African Development Bank, JICA-Japan, KfW-Germany)
- Representatives from national and international private operators in waste sector
- Representatives from national and international consulting enterprises in waste sector and Environment
- Representatives from Media and Press operators (National Radio-TV, Newspapers: Le Renouveau, etc.

Articles related to this meeting were also published in various newspapers in Arabic and in French: El Sahafa, El Sabah, El Horreya, Le Renouveau, Le Temps, and La Presse. For illustration, article releases in "Le Temps" (15 February 2006) and in "Le Renouveau" (15 February 2006) are annexed to the "Procès-Verbal".

Another national conference is also being organized for 6-7 April 2006. This conference will involve the major stakeholders of the waste sector in Tunisia, as well as national and international experts and various donor institutions. The Conference will address various issues related to the "Integrated Waste Management" in Tunisia. The two CDM projects will also be presented in one of the sessions of the conference entitled "Waste and Economy".

G.2. Summary of the comments received:

The main issues addressed by the attending persons related to technical matters involved in landfill management in Tunisia. Four major questions were raised:

- Management and compacting practices issues in Djebel Chekir and their implication in terms of space use in the landfill sites.
- Issues related to the availability of data interfering with CH4 generation (waste composition, moisture content, landfilling methods and operations, temperature inside the landfill, etc.) and the extent to which existing data or default factors might affect the project calculations.
- Direct environmental impacts of the LFG flaring.
- The reason behind the choice of the LFG flaring instead of electricity generation, which is thought to be more relevant given the international energy circumstances and perspectives.

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

Questions raised by the participants did not show any disagreement with the concept, approaches or operating conditions of the CDM project. Most of them try to stress on the difficulties to address new issues involved in higher standard waste management and landfilling, where knowledge is not perfectly mastered in Tunisia. Some others just needed additional clarification in this emerging CDM topic in Tunisia.

Regarding **management and compacting practices** issues in Djebel Chekir, lack of experience in landfill management both from the landfill operator side in managing the landfill and from ANGED side in monitoring and supervising the operating practices, should be considered as quite normal as the new management practices for wastes are still in their "teething" phase. However, overall the management of the landfill was considerably improved in the recent years, although there are still rooms for additional improvements.

The update of the Environmental Impact Assessment was one of the actions, among others, taken by the project to better identify the impacts of the landfill and to mitigate these impacts, while providing for the best conditions to maximize the quantity of CH4 to be collected for the benefit of the project.

Regarding the **data issues**, it was recalled that CH4 calculations were made using IPPC methodology and IPCC Good Practice Guidance. These methodological tools are recommended by the Conference of Parties as they represent the best available knowledge on the landfills for the time being. The calculations in the PDD have fully applied the recommendations to use national data in priority, and if not available, to use default factors recommended by IPCC. To the best possible, Tunisia data were utilized. In fact, although acknowledging the uncertainties associated with these data, they better reflect Tunisian circumstances. On the other hand, where necessary, conservative assumptions were considered to estimate emissions and emission reductions. In the end, the monitoring of emission reductions during the project execution will determine the final amounts of CERs to be marketed.

Regarding direct **environmental impacts of the LFG flaring**, it should be recalled that in the baseline situation, the major impact of Djebel Chekir relates to the important quantities of CH4 generated from the landfill, resulting in undesirable odour especially for the human establishments surrounding the Landfill site. There is also a small percentage of volatile organic compounds (VOCs), contributing to the undesirable odour.

Overall, no significant negative impacts are expected from the project activity. Flaring the collected biogas will destroy methane and thus will mitigate the above mentioned negative impacts, besides its contribution to mitigate Climate Change. Other emissions of SOx, NOx, CO and VOCs might be emitted, in insignificant quantities though. The sophisticated combustion process of the flare and the high burning temperature (over 1000°C), will ensure an almost total destruction of the exhaust gases. Moreover, the minimum required 10 m-height stack will ensure for all emitted gases to be properly evacuated and dissolved into the atmosphere.

Other risks associated with the operation of the flare will be subject to the conservative actions mentioned in section F.

Other potential risks from collecting, pumping and treatment of landfill gas will be properly controlled through the safety precautions mentioned in section F.

The project will anyway comply with the prescribed tolerance limits of the environmental regulations in Tunisia.

The rationale behind the **choice of LFG flaring instead of Electricity Generation**, lies with the much higher investment volume required for such alternative, which would totalize about 14 Million$ for Djebel Chekir. This is much beyond the Tunisian investment capacities. So, there is a major investment barrier to this alternative. Supposing this barrier can be removed, it will take some time before a financial arrangement could be prepared and made effective for such investment.

In addition, the analysis shows that the feasibility of this project is highly dependant on the extent to which the Power operator would optimize CH4 flow and suction according to the Generator characteristics and requirements. As Power generator at MSW is a delicate a, and complicated process and given the lack of experience in managing such utility in Tunisia, the technical and, thus, financial risks related to the installation of a power generator are very high at this moment.

Moreover, taking into account the low fixed selling tariff of electricity to the national Power company STEG (around 0.37 US Cts), and the complex regulatory circumstances for private power generation it is unlikely that the possible electrical generator, under a possible CDM project, would be operated before mid-2009 to the best. Opportunities to reduce significant quantities of CH4 would then be definitely lost until an electrical generator would be operational.

Annex 1

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the project.

Annex 3

BASELINE INFORMATION

The project follows the "Consolidated baseline methodology for landfill Gas Project activities – ACM0001/ version2"

Project activity meets applicability criteria of the chosen methodology. This methodology is adopted in relation with the selected approach for Baseline taken from paragraph 48 of the CDM modalities and procedures: "(b) Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment".

The suggested methodology uses the Internal Rate of Return (IRR) calculations to assess the financial attractiveness of the investment project.

The following tables show the key data and assumptions used in the case of Djebel Chekir.

INPUTS

Djebel Chekir Landfill	
Year of landfill implementation	1999
Year of landfill closure	2010
Waste in place at the project starting (tonnes)	4 616 176
Waste to be landfilled after project starting (tonnes)	2 800 000
Total landfilled Waste at the closure of Djebel Chekir (tonnes)	7 416 176
GWP for CH4	21

Baseline Data	
CH4 content of Landfill	0,5
L_0 (m3 CH4/t MSW)	100
k	0,10
Proportion of flared CH4	0%

Project Activity	
Projet starting date	July 2006
Methane Collection/Destruction efficiency	70%
Unrecovered CH4	30%

RESULTS

	10 years
Total CH4 generated (tonnes)	251 846

Emission (t CO2 e)	Emissions Baseline	Emissions Project	Emission Reductions
7 years	3 972 445	1 195 577	2 776 869
10 years	5 288 763	1 592 119	3 696 644
14 years	6 529 159	1 966 434	4 562 725
21 years	7 798 786	2 351 165	5 447 621

Annex 4

MONITORING PLAN

The management structures that will be implemented in the context of the Djebel Chekir project are as follows:

Personnel:

- ANGED will establish a unit that will be responsible of monitoring the LFG exploitation and centralizing all the relevant data.
- The LFG operator will commit at least one site staff for daily data monitoring and storage. This will be the direct counterpart of the ANGED representative for the monitoring component of the project.

Daily Monitoring Records: the site staff will record all data related to the landfill (see Section D.2.2.1) in relevant hardcopy and electronic files. Transmission of these data to ANGED unit is to be made on Weekly basis. ANGED will check for any anomalies before storing the data.

Gas Field Monitoring Records: The Site Staff checks the gas wells on daily basis, taking readings at each gas well and recording these on paper and electronic form. These readings are then checked for any anomalies before being filed at landfill site, and transmitted to ANGED. Gas field inspections will also observe occurrence of any unintended releases of landfill gas. In case unintended releases are observed, appropriate corrective action will be taken immediately.

Flaring Monitoring Records: The Site Staff checks the flaring equipment on daily basis, taking readings and recording these on paper and electronic form. These readings are then checked for any anomalies before being filed at landfill site, and transmitted to ANGED. Flare inspections will also observe occurrence of any unintended fugitive emissions of landfill gas. In case unintended releases are observed, appropriate corrective action will be taken immediately.

Routine Reminders for Site Technicians: All Site Technicians are issued with a reminder list to guide them through their daily, weekly and monthly routine. Apart from frequent telephone contacts with site staff, the Landfill Engineering Manager and ANGED representative go through this routine during site visits to ensure all aspects of the role are being performed. In addition data archived are to be checked to ensure they are appropriately maintained. This includes all data to be monitored (see D.2.2.1), as well as Wells and flares monitoring records, meter readings, etc. In addition to ensuring the site routines are being performed any additional training needs are assessed and an audit is taken of any outstanding task on site.

Outstanding Work Notice: Following the Site Audit a 'Plant Outstanding Works Notice' is issued to the Site Technician listing all the jobs that the management team consider necessary to be undertaken. This is checked on subsequent site audits to ensure these jobs have been carried out.

Permit to Work Scheme: The form is completed before any work is carried out in the LFG Gas

Field or in the flares. This is forwarded to head office and attached to the service records for each component of the LFG system. The same form is used for any works associated with the gas field or flares.

Service Sheets: Service sheets are completed for each service to ensure all aspects of the service are completed and recorded. Based on these services operators will ensure an optimum exploitation of the LFG system.

Calibration of measurement equipment: Calibration of measurement equipment will be defined and scheduled by the technology provider according to EU standards and performed by accredited Agencies.

Corrective Actions: The quality assurance measures include procedures to handle and correct nonconformities in the implementation of the Project or this Monitoring Plan. In case such nonconformities are observed:

- An analysis of the nonconformity and its causes will be carried out immediately by Djebel Chekir staff
- Djebel Chekir management will make a decision, in consultation with the ANGED, on appropriate corrective actions to eliminate the non-conformity and its causes
- Corrective actions are implemented and reported back to ANGED. All the information about monitoring plant and quality assurance measures described above, will be included in the Operational Manual, which would have been edited by the Djebel Chekir operator and validated by ANGED prior to the signature of the LFG exploitation contract. The Operational Manual will include procedures for training, capacity building, proper handling and maintenance of equipment, emergency plans. ANGED will also ensure that both the landfill site staff will receive appropriate training on the implementation of this Monitoring Plan and of the project.