Syria - سورية

Enabiling Activities for Preparation of Syria's Initial National Communication to UNFCCC

Mitigation of greenhouse gas emissions within the Wastes Sector

February 2010

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Ministry of State for Environment Affairs (MSEA),in collaboration with United Nation Development Programm (UNDP) in Syria, and Global Environmental Facility (GEF).

Project Title: "Enabling Activities for Preparation of Syria's Initial National Communication to UNFCCC", *(Project Nr.00045323).*

Assess the potential Mitigation of greenhouse gas emissions within the Wastes sector in Syria

(INC-SY_Mitigation_Wastes opportunities-En)

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Damascus **February 2010**

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This report has been approved unanimously by the technical committee, during the Technical Workshop which took place on 28.2.2010, in Samiramis Hotel, Damascus.

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Executive Summary

It becomes a request from all world countries to reduce greenhouse emissions and to develop the use of renewable energies such as biogas energy resulting from leavening of organic materials present in the domestic solid waste composition. The generated bio gas contains around 60% of methane gas. Methane gas is characterized by its relatively high thermal index, which is about 6500 kcal/m^3. Biogas can be obtained from the decomposition of waste rich in organic materials at the solid waste disposal and landfill sites.

The present report describes the proposed mitigation measures to reduce the emissions from waste sector in Syria at the final disposal sites of the domestic solid wastes in addition to wastewater and industrial waste water treatment plants in Syria.

Primary Emissions Resulting from waste Sector

According to greenhouses emissions inventory report, the total emissions from waste sector has increased during the last years due to population increase, immigration from countryside to cities and the increase in living level. Waste quantities has reached in 2005 around 3800 Gg. This quantity is considered small in comparison to emissions from other sectors such as the energy sector.

Mitigation Measures for Emissions from Waste Sector

- **Domestic Solid Waste**

Organic materials present in domestic waste compositions (around 40-60%) are considered the main generator for gases emissions resulting from leavening of these materials at the disposal sites, where methane gas constitutes the biggest percentage in these emissions at the disposal sites (around 60%). These emissions increase directly with the waste quantity increase, which is related to population number increase in cities with years and the increase of living level in addition to cities population increase in comparison with countryside. To mitigate such emissions, the following measures have been proposed for implantation:

- Make use of gases resulting from domestic solid wastes landfills for producing electrical energy
- The use of aerobic digestion techniques for waste treatment and benefit from resulting methane gas for electrical energy production
- Reduction of waste production
- National awareness for optimum handling of wastes

- Encouragement of domestic fertilizers production
- Development of waste collection procedures

- **Wastewater**

Organic materials form the biggest ratio in the composition of sludge resulting from treatment of wastewater. The ratio of organic materials present in sludge generated from wastewater treatment is about 40-60% in addition to bacteria. Organic materials are considered the first responsible for emissions resulting from wastewater treatment plants. These emissions can be reduced by the followings:

- Construction of wastewater treatment plants and using the anaerobic digestion method.
- Collection of methane gas resulting from the treatment and benefit from it in electrical energy generation

- **Industrial wastewater**

Due to industrial evolution that began in the first decade of the twenties one century, and establishing big industrial cities in the governorates, the problem of the industrial wastewater resulting from industrial activities has appeared, where organic materials contained in the industrial wastewater compositions are the main cause for methane gas emissions. To reduce such emissions, the following measures can be implemented:

- Establishing treatment plants for industrial wastewater in the industrial areas.
- Collection of gases resulting from treatment plants and use the collected gases in electrical energy generation
- For industrial facilities and small enterprises, industrial wastewater can be separated from the residual water to be treated in the central treatment plants.

Emissions that could be reduced by implementing the proposed mitigation measures

The resulting emissions from anaerobic decomposition of solid waste in the landfills varies between 10% and 23% of the total quantity of methane gas released to atmosphere. Wastewater and industrial wastewater is responsible for emission of additional 10% of methane in the atmosphere.

In the case of accepting the domestic landfill concept as an option for treating solid wastes and recovering methane gas as methodology to reduce the greenhouse gases, and by considering that every tone of waste produces theoretically 300-1500 m^3 of biogas annually. Because of the difficulties in extraction of the gas and management of conditions underground, the production efficiency varies between 25% and 50%. In the case of accepting the biological treatment of organic solid waste, the production and collection of methane gas varies between 30% and 50 with an average of 40%.

At the wastewater and industrial wastewater treatment plants when applying the biological treatment and collection of methane resulting as a method to reduce emissions of greenhouse gases. By considering the emissions from industrial wastewater is equal to 10% of the emissions from wastewater and due to some technical difficulties in gas collection, the efficiency of production and collection of methane gas is around 25%.

Positives impacts of the proposed measures

By considering the application of the proposed measures for reducing greenhouse gases emissions, the global warming phenomena is reduced and hence gaining positives economical, social and environmental impacts.

Summary

Emissions from disposal sites of domestic solid wastes constitute of 88% from the total emissions of waste sector. The emissions resulting from wastewater treatment plants reaches 11% while the lowest emission percentage was from industrial wastewater treatment plants, which is 1%. To mitigate such emissions, some measures can be applied for construction of treatment plants and using modern techniques to recover methane gas and convert it to electrical energy.

A Report on Mitigation Measures for Greenhouse Gases Emissions from Waste Sector

1. General Introduction

The fast in growth in population, increase in living levels, improvement of services in addition to industrial and agricultural evolution have resulted in an increase in domestic solid waste production in the public communities, therefore, there was a need to find appropriate solutions to dispose such wastes, wastewater and industrial wastewater scientifically and environmentally safe.

Organic materials constitute the biggest percentage of the domestic wastes in Syria, where the organic materials percentage in the domestic solid wastes is about 57%. Organic materials constitute also the biggest percentage in wastewater and their percentage in resulting sludge from wastewater is about 40-60%. These materials are considered the main responsible for emissions resulting from the domestic solid waste, due to its decomposition and leavening in the final disposal sites of waste, wastewater treatment plants in cities and industrial wastewater treatment plants from factories and industrial facilities.

2. Primary Emissions Resulting from Waste Sector

Methane gas is considered the main emission from waste sector. These emissions will be calculated for each part of it (domestic solid waste, wastewater, industrial wastewater).

2.1. Solid Wastes

Emissions resulting from domestic solid waste can be calculated after knowing the quantity of waste generated and collected in the domestic landfills in addition to expectation on the quantities to be generated in the future.

2.1.1. Solid waste quantities in Syria during the period 1994-2000 and the period 2000-2008:

Disposal sites for domestic solid wastes spread at the edges of Syrian cities and governorate are still the final site to collect all generated waste. But, Damascus governorate has constructed a factory for treatment of solid waste late 1990. The factory treats part of the waste resulting from Damascus City. The remaining quantity is sent to nearby landfill. Figure 1 shows Organic

Materials Percentage in Mean Waste Quantities Generated from the Syrian Governorates in 2002 .

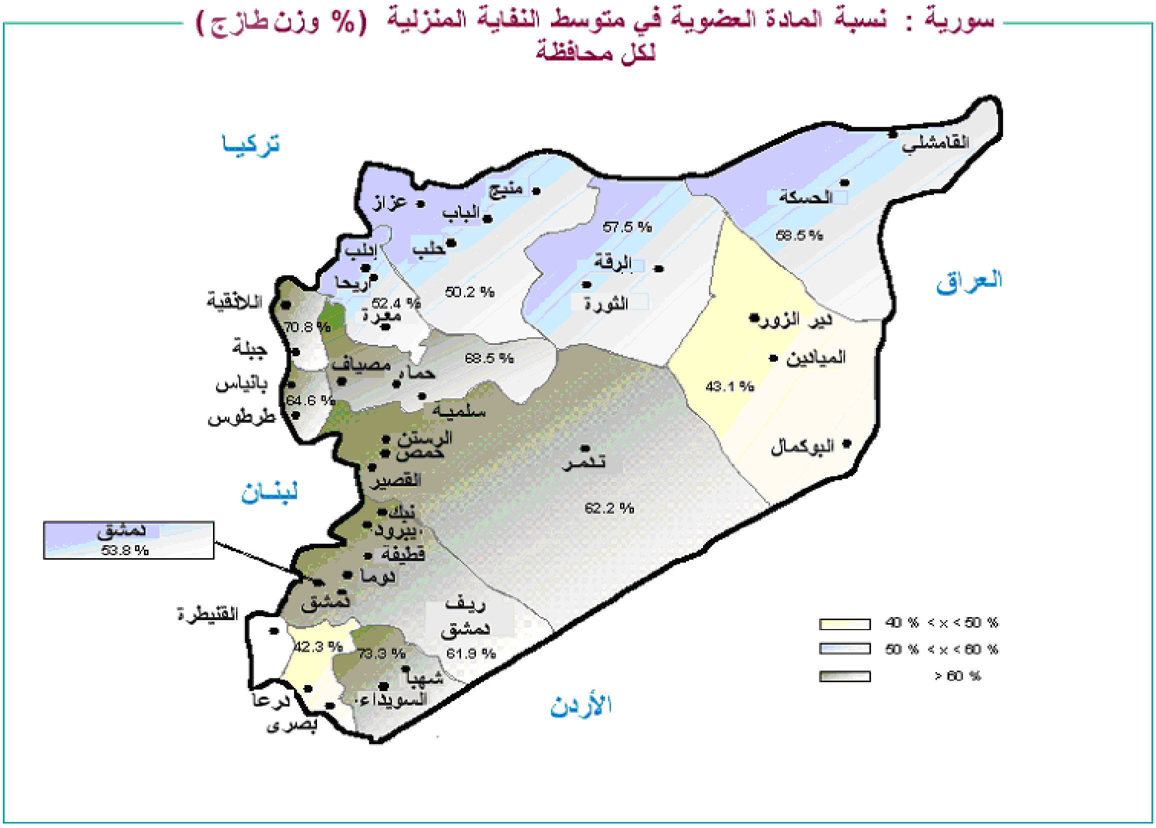

Figure 1. Organic Materials Percentage in Mean Waste Quantities Generated from the Syrian Governorates in 2002 (Reference 1)

The daily production of waste per person is about 0.5 kg and the organic materials contained in the domestic solid waste is responsible for generating gaseous emissions. Table 1 shows the Organic materials quantities collected in the final disposal sites during the period 1994-2008.

Table 1. Organic materials quantities collected in the final disposal sites during the period 1994-2008.

Year	City Inhabitants	Person Production Rate Kg/Day	Total Waste in the Landfill Kg/Day	Organic Materials Percentage (%)	Total Organic Waste Kg/Day
1994	9091800	0.5	4545900	0.57	2591163
1995	9344400	0.5	4672200	0.57	2663154
1996	9603600	0.5	4801800	0.57	2737026

1997	9870000	0.5	4935000	0.57	2812950
1998	10144200	0.5	5072100	0.57	2891097
1999	10425600	0.5	5212800	0.57	2971296
2000	10714800	0.5	5357400	0.57	3053718
2001	11012400	0.5	5506200	0.57	3138534
2002	11318400	0.5	5659200	0.57	3225744
2003	11632800	0.5	5816400	0.57	3315348
2004	11955600	0.5	5977800	0.57	3407346
2005	12287400	0.5	6143700	0.57	3501909
2006	12502945	0.5	6251473	0.57	3563339
2007	12793129	0.5	6396565	0.57	3646042
2008	13083313	0.5	6541657	0.57	3728744

Reference No. 5

2.1.2. Expected emissions from domestic solid waste during the period 2008-2030

Disposal sites of domestic solid wastes are distributed at the edges cities, villages and administrative units, and the organic materials contained in the domestic solid waste is considered the primary generator to methane gas as a results of leavening of these materials at the disposal sites.

Based on the report of greenhouse gases inventory from the waste sector, and according to solid waste quantities from Syrian cities and governorates, it can be seen that the quantities of gases resulting from the leavening of waste in the landfill during the period 2009-2030 increase directly and Figure 2 shows the expected Methane Gas Quantity from Solid Waste During the Period 2009-2030

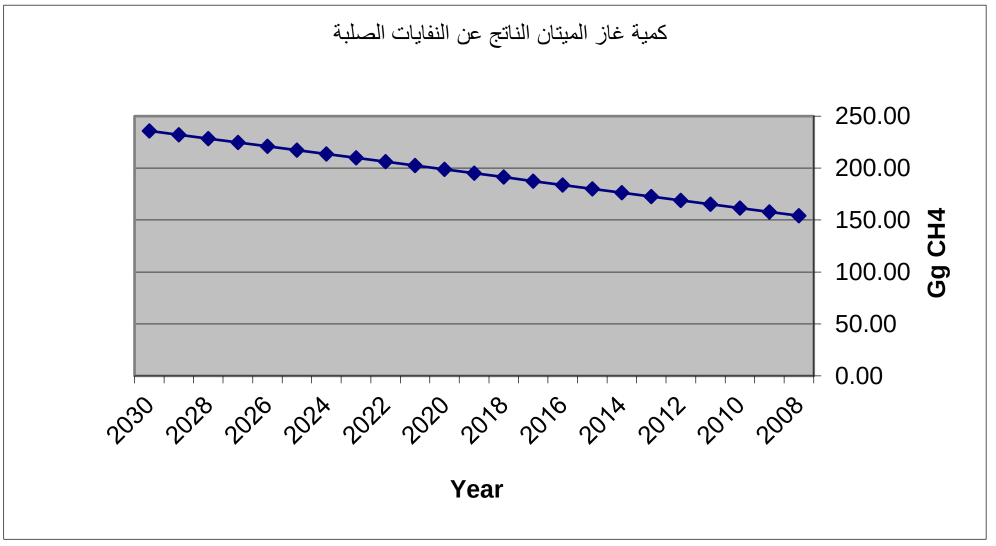

Figure 2. Expected Methane Gas Quantity from Solid Waste During the Period 2009-2030

2.2. Wastewater

A number of wastewater treatment plants have been operated. Damascus and Aleppo wastewater treatment plants are considered the largest plants in Syria. Wastewater networks are currently being enlarged and maintained in small cities and countryside areas in addition to construction of model small treatment plants with low costs for communities not more than 10,000 inhabitants.

The need for purification of wastewater with increasing demand for re use of the treated wastewater has lead to standards and specifications related to its purifications to ensure the highest environmental and health safety degrees in the case of reuse of this water or discharge into the environment. The organic materials present in wastewater have the biggest effect in producing the gaseous emissions from treatment plants where methane gas is the most important among these emissions. Figure 3 shows methane gas quantity generated from wastewater treatment plants during 1994-2008.

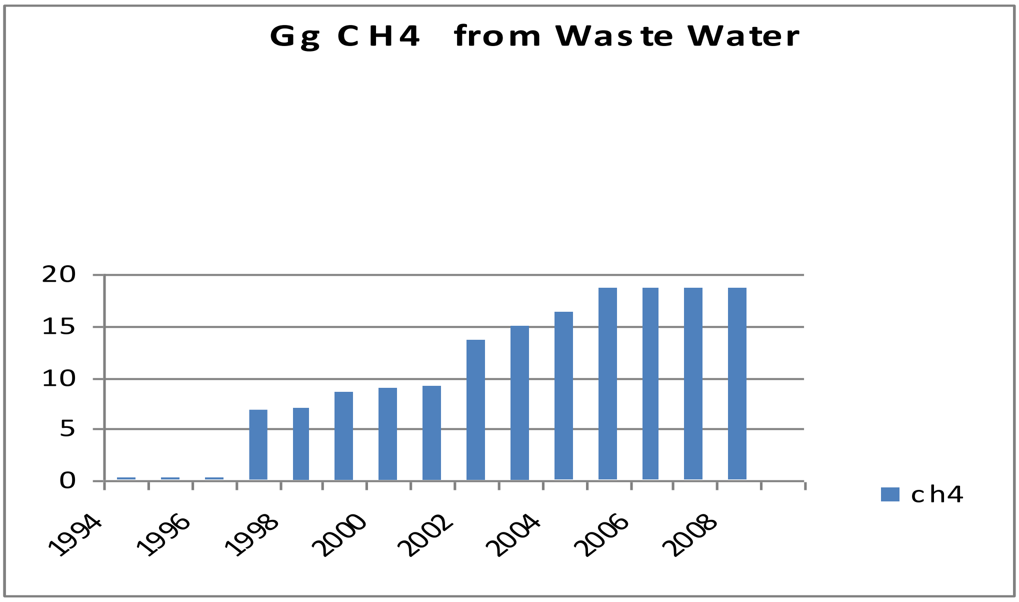

Figure 3. Methane Gas Quantity Generated from Wastewater Treatment Plants During 1994-2008

By considering that all cities and communities in Syria will be provided by wastewater treatment plants during the period 2009-2030, the expected methane gas quantity generated from these plants has been calculated. Figure 4 shows the expected methane gas quantity from wastewater during the period 2009-2030

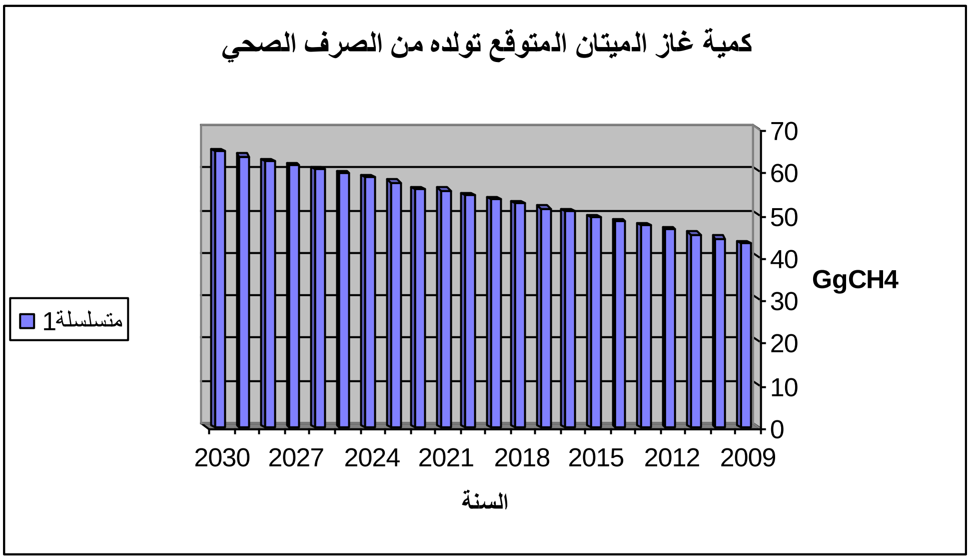

Figure 4. Expected Methane Gas Quantity from Wastewater During the Period 2009-2030

2.3. Industrial Wastewater

Wastewater companies and environmental directorates in the governorates apply strict procedures to control the industrial wastewater before discharge into main sewer to separate the hazardous matters from the wastewater. A standard for water allowed to be disposed off into the general sewer network has been formulated under the name "Liquid Waste Resulting from Economical Activities and Discharged into the General Sewer Network" and according to Environment Law No. 50 of 2002, and the executive instructions for environmental impact assessment and environmental audit for industrial activities, the environmental directorates in the governorates follow up all industrial activities, which produce wastewater, and enforce them to construct treatment plants for their industrial wastewater.

For industrial sector, big industrial cities in the governorate have been established such as Addra, Hesseih, Al-Shek Najar,… and there are some areas organized in cities and governorates.

Most of the industrial activities discharge the wastewater into the domestic sewer, where the water is treated with wastewater in the treatment plant if it is present. Some of the industrial activities have constructed purification and treatment plants for the industrial wastewater, and the environment directorates in the governorates (according to Environment Law No. 50),enforce the owners of the industrial activities to construct treatment plants for industrial wastewaters resulting from the activity.

3. Mitigation Measures for Emissions from Waste Sector

The organic materials contained in waste composition are responsible for gaseous emissions, where the anaerobic digestion is the main process for decomposition of the contained materials in its composition. The resulting biogas from leavening of organic materials in waste landfills, can be used. This bio technique has been developed in several countries from the world.

The collection system of the resulting biogas from the anaerobic leavening of wastes is used for producing energy instead of slow leaking to ambient air and surrounding areas, and its negative impact in the global warming; the gas can also be burnt out using flares. The use of biogas as a source of energy will limit the global warming since the waste will decompose in the landfill. The recovery of biogas will decrease the consumption of the carbon fossil fuel reserve.

3.1. Mitigation Measures for Domestic Solid Wastes

The following procedures can be applied to mitigate the resulting emissions from domestic solid waste:

3.1.1. Implementing the national strategy for solid wastes

The national strategy for solid waste management in Syria was issued in 2004, and the conversion of organic materials in domestic solid waste to fertilizers (compost) for soil improvement after sorting in sorting plants, in addition to domestic landfill as parallel solution to bury the refusals resulting from natural compost plants. The construction of domestic landfills is accompanied with the construction of generated biogas collection system.

3.1.2. Collection of gases resulting from domestic solid waste landfills and their usage in electrical energy generation

Waste landfills may produce significant amounts of biogas that could be recovered and collected so it can be sued as energy source in many applications requiring the energy.

- **Recovery of biogas from closed domestic waste land fill**

The recovery can be done by drilling several vertical collection wells where the distance between each two successive wells from 60-80 m and the biogas is collected from the wells using a horizontal network buried or above the surface of the final landfill.

Well drilling is carried out using a drilling machine with 300 mm diameter to below waste layer in the landfill. Supported pipes are installed to avoid well opening collapsing. A polyethylene pipe of 150-200 mm is placed inside the hole. The plastic pipes consist of solid pipes at the well head and pipes surrounded by holes located along the rest of the pipe inside the landfill. The hole size in the plastic pipes is 4 mm, where the pipes are drilled vertically.

The pipes are connected by polling using a spiral and the space between the well opening and the plastic shaft is filled with rocks and gravels.

When the landfill becomes full of waste and there is a possibility of immersion of all collection wells or part of them, wells with 700 mm diameter should be drilled and provided with plastic shafts of 400 mm diameter to allow the installation of immersion pump to collect water.

The plastic shafts in the aerial horizontal collection network are placed at 2 meter distance from landfill surface.

Photo 1. A Model for Horizontal Collection of Gas Pipes in a Landfill (Reference 10)

- **Recovery of biogas from waste landfill under exploitation**

In the case of a landfill under exploitation, biogas collection wells are constructed gradually while filling the landfill pit. Collection wells in this case could be a channel made of concrete with holes, the diameter of the channel is 1000 mm. the channel is closed gradually with filling of the landfill. Each collection well is provided with a plastic shaft perforated. The diameter of each shaft is 150-200 mm. the distance between the shaft and well is filled with rocks and gravels to form gaseous mixture with this distance. After exploitation of each pit in the landfill, the collection wells in this pit are connected by a horizontal collection network buried or surface.

The generated gas from domestic landfills is used for burning in ovens and boilers to produce steam for electrical power generation. Or for producing hot water for heating purposes. Every one tone of waste produces theoretically 300-1500 m^3 of biogas. Due to difficulties in extraction of the gas and management of conditions underground, the production efficiency varies between 25%-50%.

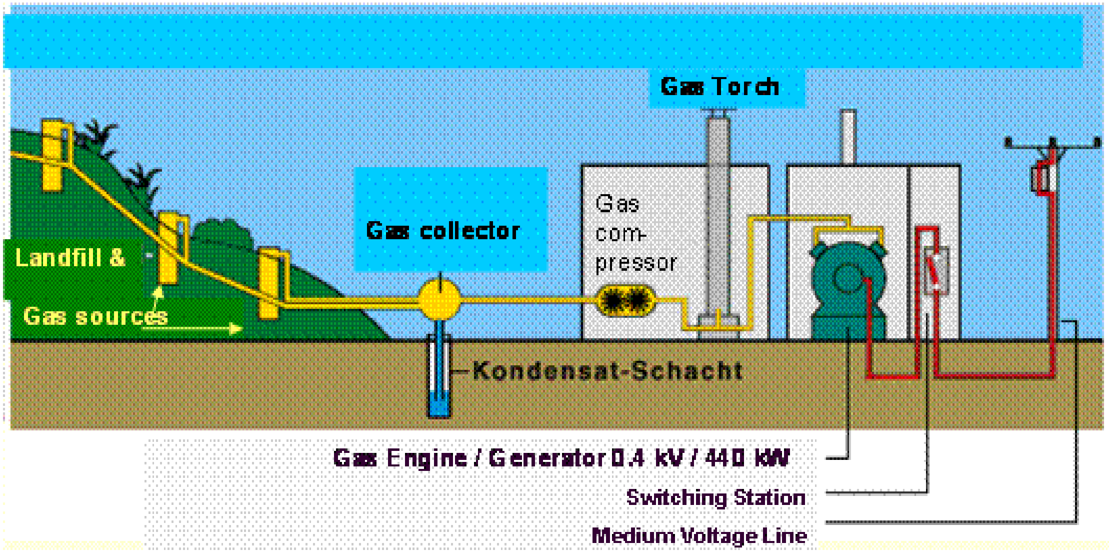

Figure 5. Simple Diagram for Electrical Energy Generation Mechanisms from Landfills (Reference 10)

The cost of energy generation from a landfill gas is very encouraging since the energy production from these systems varies between 4-6 American cent for one watt-hour (Reference 4).

3.1.3. The sue of anaerobic digestion for waste treatment and beneficiation from the resulting methane for electrical energy generation

Large part of the interest on the anaerobic digestion of waste technology is based on the objective to have a renewable energy resource, represented by the biogas generated from the digestion, where we obtain from digestion of one tone of waste susceptible to biological conversion to the biogas, 120 m^3 of biogas. In addition, a secondary product is also obtained, which is the residual liquid from the digestion, which is free of pathogen germs. Around 0.4 tone of residual solution from the digestion is produced from one tone of waste. The residual quantity resulting from digestion of organic waste differs from the remaining quantity by waste type differences, the residual material distributed between the biogas and the digested solution, these liquid outlets can be removed, dried and dewatered.

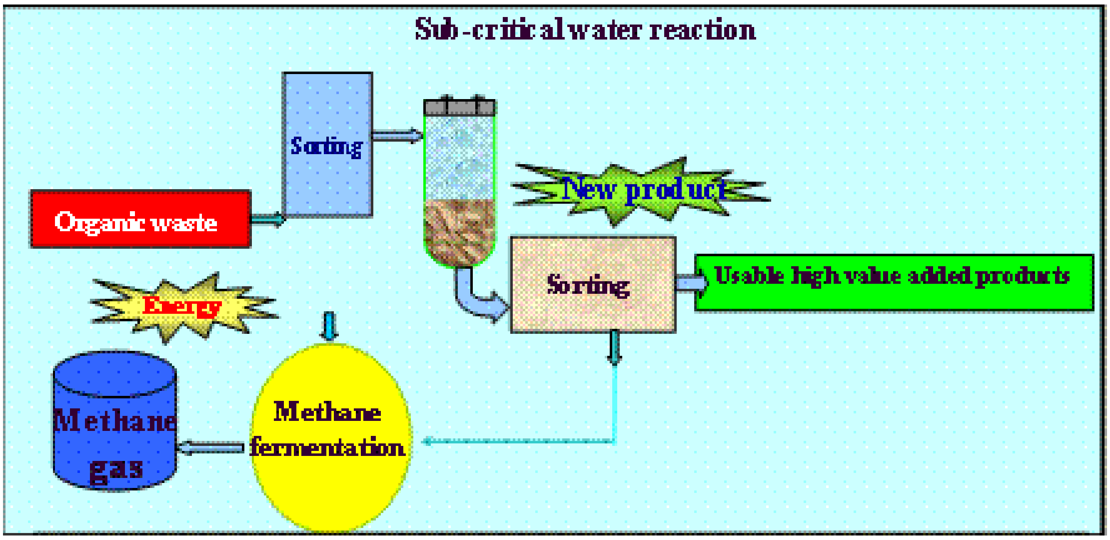

Figure 6. Simple Diagram for Organic Waste Treatment Reactor with Addition of Wastewater (Reference 10)

The resulting solid material after dewatering consist of solid materials (Humic) and nutrition. The solid material is used to amend the agriculture soli properties and increase its capacity to retain water since the anaerobic digestion does not remove the organic materials but changes its composition. The resulting material contains all phosphorus quantities and potassium approximately and about 90% of the nitrogen quantity present in waste prepared for digestion.

The resulting solid materials is marketed where it is dedicated for mixing with agriculture soil to retain its fertility and increase organic matter in it. The solid portion can be added to arid sandy lands to amend and include them in the agriculture production. The addition of solid matter resulting from digestion to soil will contribute to the following benefits:

1. Soil protection from erosion caused by heavy rain water
2. Reduction of non penetrating solid layers formation at the soil surface
3. Increasing exchangeable capacity of the soil and addition of variable quantities of elements necessary for plant growth.

The resulting biogas from digestion process contains 40-60% of methane and the thermal value of the biogas differs according to the methane percentage in the biogas, where the general mean thermal value is estimated by 5600 k cal/m^3.

The produced biogas in the rector is collected and it can be used in the followings:

- A portion of the biogas is used as internal consumption for equipment required to produce the biogas with the treatment center and the remaining portion is prepared for marketing.
- Biogas can be used as fuels for stoves instead of natural gas. The stoves can be modified by widening the gas inlet opening and decreasing the opening of air inlet required for burning so the ratio of the two gases are suitable. The flare opening should be widened to decrease the velocity of the gas mixture emission so the flare will not winked.
- The biogas can be used for lightning using bulbs made of shimmy for this purpose. These bulbs are used for houses lights and big chicken breeding farms and others.
- The biogas has been successfully used for operation of internal consumption engines that are operated using benzene provided that some small modifications on fuel circuit should be conducted. In the case of using biogas in diesel engines, the efficiency of the engines decrease by 20% and their efficiency can be increased by removing carbon dioxide and hydrogen sulfide from the biogas to avoid metal pieces corrosion. The biogas pressure should be increased when it is used for mobile internal combustion machineries (cars, trucks,..). this can be done by filling the biogas in cylinders under high pressure and low temperature.

The propagation process and beneficiation from biogas resulting from leavening of organic materials contained in domestic solid waste, require wide national programs.

3.1.4. Reduction of waste production

Reduction of waste means that any effort to reduce or recycle the quantity of the generated wastes and hence reducing the emissions produced by leavening of organic materials contained in the solid waste.

It is possible to look forward to spread the 3R principle in handling the solid wastes (reduction, reuse, recycle). If the consumers have been supported by the government, commercial and industrial activities and concerned environmental societies, they will be ready to interact with reduction of waste production programs; this can be enhanced more by changing the thinking, culture, habits and behavior than legislations.

3.1.5. National awareness

It should look forward to acclimatization with good habits and behaviors. This means organized and continuous awareness campaigns, the awareness activities can be carried out through:

- Central campaigns: with public participation and some supporting companies
- Scholl and university students
- Special awareness campaigns (industries, women unions,..)
- NGO's such as environmental societies

It is possible to carry these campaigns via:

- Information: TV advertisement, road ads, posters, children games,..
- Providing support for waste recycling programs
- Organizing workshops about the optimum use of wastes

3.1.6. Encouragement of domestic fertilizers production

It is possible to look forward for reduction of emissions resulting from domestic solid waste by encouraging people to produce domestic fertilizers where the organic materials contained in domestic waste composition and agriculture waste are responsible for these emissions. This practice can be supported and especially in countryside areas and suburbs. The practice requires water to complete the leavening process better, where without water, the organic materials will not be converted into fertilizers in the fertilizers boxes. It is possible to promote the domestic fertilizer production through:

- Group training (at the garden)
- Promotion at the public places
- Promotion in schools (production of fertilizers by students)

3.1.7. Development of waste collection processes

It is possible to look forward to reduce emissions from domestic solid waste by developing the management of domestic solid waste collection and transportation and by applying separation programs of organic materials from the source to avoid accumulation within the waste containers or in cities edges, therefore, avoiding leavening process of these materials and beginning of gaseous emissions. These programs can be carried out via:

- Supporting local authorities and governorate by containers, machineries and manpower for organized collection of the waste
- Improvement of waste management (collection, transferring, treatment, final disposal)
- Involve the private sector in cleanness works
- Promotion for applying separation of the organic materials at the source programs.

2.3. Mitigation Measures for Wastewater Treatment Plants

Some executive procedures can be applied to mitigate emissions resulting from wastewater according to the following steps:

2.3.1. Implementation of the national strategy for wastewater and construction of wastewater treatment plants in Syrian governorates and cities

The planned wastewater treatment plant in the Syrian cities and governorates should be completed and especially where there is no wastewater treatment plant, it is preferable in this filed to use anaerobic digesters in the treatment, which are able to recover the biggest quantity of methane gas resulting from digestion and decomposition of organic materials.

Photo 2. A Model for Anaerobic Digestion Tanks in Wastewater Treatment Plant

2.3.2. Recovery of methane gas resulting from treatment

The resulting gases from central treatment plants, which use anaerobic digestion method, are collected. The gases are used for electrical energy generation. The energy is used for operational processes with the plant (lightning, water pumps operation,…) or in central heating operations. The overflow electrical energy is sent to general grid of the electricity in the area that the plant is located in.

Photo 3. A Model for Electricity Generator Unit from Methane Gas in Wastewater Treatment Plant (Reference 9)

2.4. Mitigation Measures for Industrial Wastewater

Some executive procedures can be applied to mitigate the emissions resulting from the industrial wastewater by:

2.4.1. Construction of industrial wastewater treatment plants:

Different liquid streams from industrial activities are produced according to industry type, the raw materials used in the industry, production process and final products. There are analytical parameters for industrial wastewater (COD, BOD, PH,..) that form a main factor for selecting the appropriate method for treatment of these streams and this can be performed by:

- Construction of plants to separate industrial wastewater from the wastewater network in the industrial facilities.
- Construction of treatment plants for industrial wastewater applying the anaerobic decomposition
- Construction of central treatment plants for industrial wastewater in the central industrial cities distributed in the Syrian governorates (Addra, Hesseih, Al-Sheik Najar,..)
- Construction of central treatment plants for industrial areas dedicated for special industries such as tanning industries area in Damascus, textile industry areas in Aleppo,…..

2.4.2. Collection of gases resulting from treatment plants

The resulting gases from industrial wastewater treatment plants can be collected and the emitted methane gas (CH_4) after separation from other undesired gases such as H_2S, can be used for electrical energy generation. The electrical energy produced can be used in the following fields:

- Operation of machines and industrial equipment within the production process in the industrial facilities
- Lightning streets and nearby villages from the treatment center
- The overflow electrical energy can be transferred to the main electrical grid.

2.4.3. Industrial facilities and small enterprise

In the case of impossibility of construction of industrial wastewater treatment plants in small industrial facilities, distributed here and there such as car washings shops, the following procedures can be applied:

- Construction of a plant to separate the industrial wastewater from wastewater
- Discharge the water after separation to treat within the wastewater treatment plant in the city or in the central plant within the governorate.
- Apply the appropriate technical methods to extract the methane gas within the central treatment plan and use in electrical energy generation

4. Emissions Quantity that Could be Reduced by Implementing the Proposed Mitigation Measures

The emissions resulting from the anaerobic decomposition of solid waste in the landfills, forms 10%-23% from the total quantity of methane gas emitted into the atmosphere. Wastewater and industrial wastewater are responsible for another 10% of methane emissions into the atmosphere. Paper industry, food industry and beverages industry and transmutation industries are responsible for emissions resulting from industrial wastewater (reference 4).

4.1. Solid Waste

4.1.1. Domestic Landfill

In the case of considering the domestic landfill form as an option for solid waste treatment and the recovery of methane gas as a methodology to reduce the greenhouse gases, and by considering that every tone of waste produces theoretically between 300-1500 m^3 of biogas. Due to difficulties in extraction of gas and the management of conditions underground, the production efficiency varies between 25% and 50%, the emissions quantity that could be reduced, can be calculated. Table 2 shows methane gas quantity that could be reduced in the final disposal sites during the period 2009-2030

Table 2. Methane Gas Quantity that Could be Reduced in the Final Disposal Sites During the Period 2009-2030

Year	Methane Gas Quantity Gg CH4	Minimum Limit for Reduction Gg CH4	Maximum Limit for Reduction Gg CH4	Mean Rate Gg CH4
2009	**157.86**	39.47	78.93	59.20
2010	**161.57**	40.39	80.79	60.59
2011	**165.28**	41.32	82.64	61.98
2012	**168.99**	42.25	84.50	63.37
2013	**172.70**	43.18	86.35	64.76
2014	**176.42**	44.11	88.21	66.16
2015	**180.13**	45.03	90.07	67.55
2016	**183.84**	45.96	91.92	68.94
2017	**187.55**	46.89	93.78	70.33
2018	**191.26**	47.82	95.63	71.72
2019	**194.98**	48.75	97.49	73.12
2020	**198.69**	49.67	99.35	74.51
2021	**202.40**	50.6	101.2	75.9
2022	**206.11**	51.53	103.06	77.29
2023	**209.82**	52.46	104.91	78.68
2024	**213.54**	53.39	106.77	80.08
2025	**217.25**	54.31	108.63	81.47

2026	**220.96**	55.24	110.48	82.86
2027	**224.67**	56.17	112.34	84.25
2028	**228.38**	57.10	114.19	85.64
2029	**232.10**	58.03	116.05	87.04
2030	**235.81**	58.95	117.91	88.43

Figure 5 shows the total quantities of methane gas emissions from solid waste during the period 2009-2030 and the mean rate of the quantity that could be recovered using waste landfill to generate electrical energy.

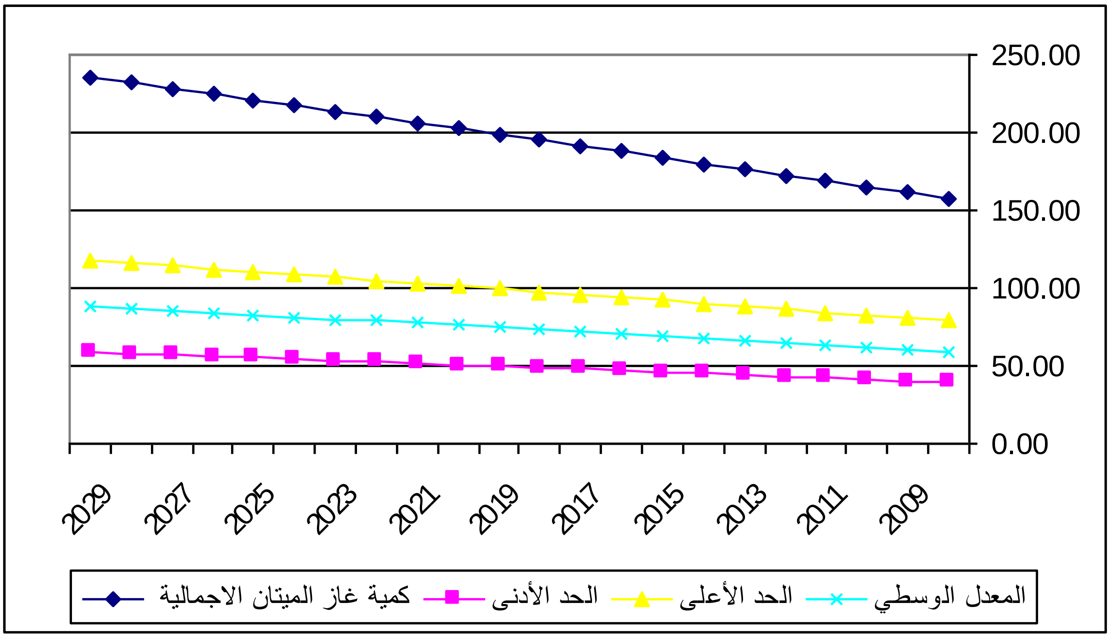

Figure 5. Total Quantities of Methane Gas Emissions from Solid Waste During the Period 2009-2030 and the Mean Rate of the Quantity that Could be Recovered Using Waste Landfill

4.1.2. Biological Treatment

In the case that the biological treatment is considered for solid waste treatment, and collection of the resulting methane gas as a methodology to reduce emissions of the greenhouse gases provided that the using of this method will not omit the use of domestic landfills as a parallel principle, but reduces from the waste quantity sent to landfill. By considering that every one tone of waste produced theoretically annually between 300-1500 m^3 of biogas. Due to some technical difficulties in gas collection, the production and collection efficiency varies between 30% and 50% with an average value of 40%. The emission quantity that could be reduced can be calculated. Table 3 shows the methane gas quantity that could be reduced during the period 2009-2030.

Table 3. Methane Gas Quantity that Could be Reduced During the Biological Treatment of the Solid Waste During the Period 2009-2030 (2030 – 2009)

Year	Total Quantity Gg CH4	Methane Gas Quantity that Could be Reduced Gg CH4
2009	157.86	63.15
2010	161.57	64.63
2011	165.28	66.12
2012	168.99	67.60
2013	172.70	69.08
2014	176.42	70.57
2015	180.13	72.06
2016	183.84	73.54
2017	187.55	75.02
2018	191.26	76.56
2019	194.98	78.00
2020	198.69	79.48
2021	202.40	80.69
2022	206.11	82.45
2023	209.82	83.93
2024	213.54	85.42
2025	217.25	86.90
2026	220.96	88.39
2027	224.67	89.87
2028	228.38	91.36
2029	232.10	92.84
2030	235.81	94.33

Figure 6 shows the total emissions of methane gas from solid waste during the period 2009-2039 and the emissions that could be reduced using the biological treatment of the organic wastes and recover the methane gas for usage in electrical energy generation.

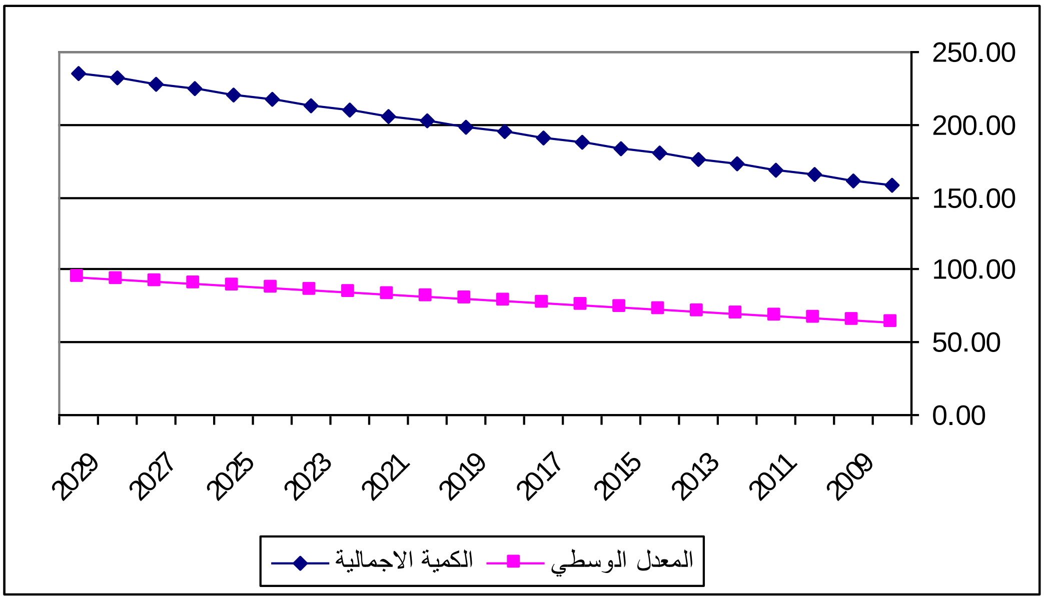

Figure 6. Total Quantity of Methane Emissions from Solid Waste During the Period 2009-2030 and the Mean Rate of the Quantity that Could be Recovered Using the Biological Treatment of the Organic Wastes.

4.2. Wastewater and Industrial Wastewater

In the case of the biological treatment in wastewater and industrial wastewater plants has been approved and the collection of methane gas as a method for reducing greenhouse gases emissions and by considering the emissions of industrial wastewater is equal to 10% from the emissions of the wastewater and because of some technical difficulties in gas collection, the production and collection efficiency of methane gas as a mean rate is 25%. The emission quantity that could be reduced can be calculated. Table 4 shows the methane gas quantities that could be reduced during the period 2009-2030.

Table 4. Methane Gas Quantity that Could be Reduced from the Wastewater and Industrial Wastewater Plants During the Period 2009-2030

Year	Wastewater Gg CH4	Industrial Water Gg CH4	Total Quantity Gg CH4	Methane Gas Quantity that Could be Reduced Gg CH4
2009	43.33	4.33	47.66	11.92
2010	44.35	4.44	48.79	12.20
2011	45.37	4.54	49.91	12.48
2012	46.39	4.64	51.03	12.76
2013	47.41	4.74	52.15	13.04
2014	48.42	4.84	53.26	13.32
2015	49.45	4.95	54.4	13.60
2016	50.64	5.06	55.7	13.93

2017	51.48	5.15	56.63	14.16
2018	52.5	5.25	57.75	14.44
2019	53.52	5.35	58.87	14.72
2020	54.54	5.45	59.99	15.00
2021	55.65	5.57	61.22	15.30
2022	55.85	5.59	61.44	15.36
2023	57.6	5.76	63.36	15.84
2024	58.62	5.86	64.48	16.12
2025	59.64	5.96	65.6	16.40
2026	60.65	6.07	66.72	16.68
2027	61.67	6.17	67.84	16.96
2028	62.69	6.27	68.96	17.24
2029	63.71	6.37	70.08	17.52
2030	64.73	6.47	71.2	17.80

Figure 7 shows the emissions quantity rate of methane resulting from wastewater and industrial wastewater during the period (2009-2030), and the quantity that could be recovered and benefit from it for electrical energy generation.

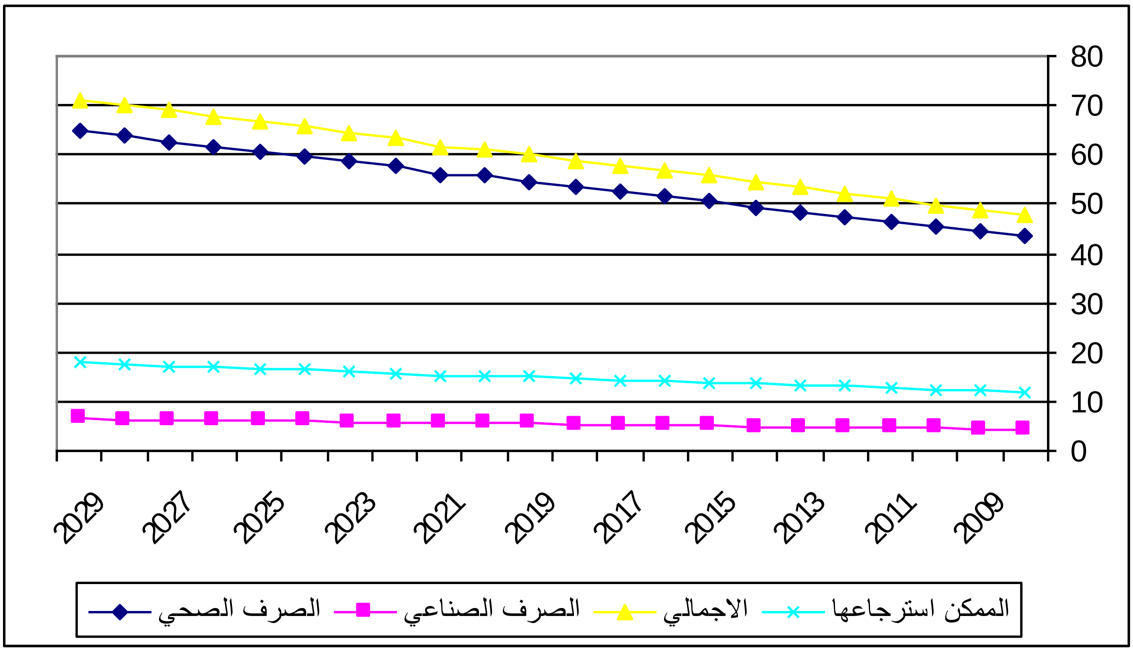

Figure 7. Methane gas emission rates from wastewater and industrial wastewater during the period 2009-2030

5. Positive Impacts of the Proposed Measures

Generally, the proposed mitigation measures for reducing greenhouse gases emissions will have a positive impact on the environment by reducing the global warming phenomena , these can be seen in the positive impacts, some of which are:

5.1. Economical Impacts

- Providing new renewable resource for electrical energy
- Reducing the consumption of primary energy resources (oil, gas,..)
- Activate the use and development of modern techniques for treatment of solid wastes and wastewater and industrial wastewater
- The reduction of illnesses resulting from unorganized disposal of wastes.

5.2. Environmental Impacts

- Mitigation of the negative impacts of the unorganized disposal of solid waste and from wastewater and industrial wastewater on soil, water and air.
- Protection of surface and ground water
- Limiting the global warming phenomena

6. Conclusions

Looking for mitigations from negative impacts of the gaseous emissions resulting from waste sector (solid waste, wastewater and industrial wastewater) is related to spending more money in order to protect the environment and sustainable development, where the cost of a sanitary landfill varies between 15 and 50 USD per one tone of solid waste and the cost of a biological treatment varies between 80 and 140 USD for one tone of solid waste.

The application of the proposed mitigation measures according to a scheduled program, is related to preset plans and strategies to execute sanitary landfills and wastewater and industrial wastewater treatment plants. The application of modern technology in treatment of domestic solid waste and executing wastewater and industrial wastewater treatment plants, will benefit from the resulting emissions from waste sector and mitigate the impacts of the greenhouse gases effects (global warming) and convert them into electrical energy so they will be along with the primary energy recourses (oil and gas) and to renewable energies such as sun energy and wind energy. In spite of all mitigation measures and the technical techniques in treatment, the gaseous emissions find their ways to the atmosphere.

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