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

Mitigation of greenhouse gas emissions within the industrial sector in Syria

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

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Mitigation of greenhouse gas emissions within the Industrial sector in Syria

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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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1. Introduction

The phenomena of global warming in the twenty-first century is one of the most important issues inherited from the last century, which concern scientists and neighborhoods (mankind) due to climatic changes caused to earth which began reflecting increased global temperatures and rising seas and oceans, natural disasters and floods.

The main gases cause the global warming in terms of quantity and breadth are carbon dioxide, nitrogen dioxide, and methane, in addition to other gases which their presence is small but their impact is very large.

Industry today is one of the key sources of greenhouse gas emissions due to fuel consumption for thermal power generation, motors or industrial processes themselves, such that the reduction of these emissions is one of the important steps to reduce global warming.

2. Industrial Sector in Syria

The industrial sector in Syria is one of main sectors contributing to greenhouse gases through the emitting of greenhouse gases CO2, N2O, CH4, HFCs, PFCs, SF6, due to the combustion of fuel for thermal and motive energy or through the physical and chemical changes accompanying the industrial processes fabricated (1).

Industry in Syria is divided between three sectors: public, private and joint. The Ministry of Industry is responsible for the manufacturing industry, where they are concentrated the most of the major industries of the public sector companies of the state.

The Ministry of industry has 8 industrial establishments with 91 companies(2) which they are:

- General establishment of cement and construction materials
- General establishment of chemical industries
- General establishment of engineering industries
- General establishment sugar industries
- General establishment food industries
- General establishment textile industries
- General establishment cotton industries
- General establishment of tobacco industries

3. Energy Consumption in Industry

Industrial sector uses a different kinds of fuel oils for energy uses (beside the electrical energy), and the most important in terms of quantity and breadth of use is a heavy fuel oil and diesel oil as well as gasoline, kerosene and natural gas. Table (1) clarify the amount of fuel consumed in various industries, by Ton Oil Equivalent (TOE), during the period between 1994-2005 in the main industrial establishments with the most energy-consuming which they are as follows(2):

- General establishment of cement and construction materials
- General establishment of chemical industries
- General establishment of engineering industries
- General establishment of sugar industries
- General establishment of food industries
- General establishment of textile industries

Table (1) fuel consumed in different industries TOE[1]

TEO	CEMENT	TEXTILE	FOODS	CHEMICAL	SUGAR	ENGINEERING
1994	464882	40098	25443	70712	97304	4000
1995	500932	38519	28600	68639	105135	9066
1996	491856	36907	27685	75573	82378	17187
1997	480016	38514	45099	76827	81101	14928
1998	445544	34075	23381	79946	67358	18045
1999	440189	34312	23640	65598	82408	15004
2000	443456	31269	24864	72432	68482	13706
2001	430494	31015	19847	71411	74597	13420
2002	428425	31534	22180	76472	97365	12613
2003	442097	29518	21526	67254	95420	12790
2004	412848	32786	23094	77600	93314	11726
2005	418286	32641	23434	74542	74648	12280
2006	435292	31187	21982	15339	190063	12547

Source (2)

Figure (1), clarify the energy consumption in industry, divided into industrial establishments during 1994-2006 where it seems that the biggest consumption of fuel (fuel and diesel) is in the cement industry, followed by the chemical industry, textile, sugar, food and finally the engineering industry, and the rate of total energy consumption for Heavy Fuel Oil (HFO) is decreased and the reason for that is reducing the use of it and the entry of new types of energy sources such as natural gas (3) instead of HFO.

(2) - Ministry of Industry data output and energy consumption 1994-2005 (2)[1]
3) - Ministry of Oil quantitative data produced 1994-2005

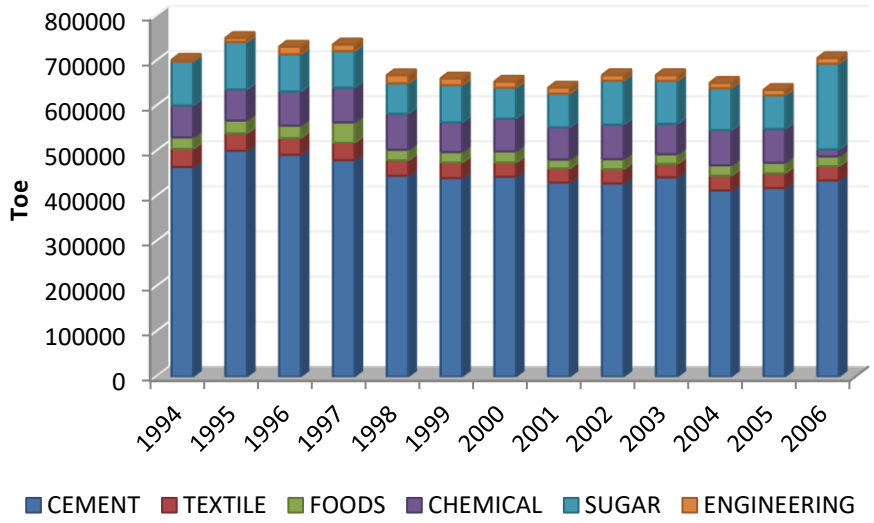

Figure (1), fuel consumed in industrial establishments

Figure (2), shows the share (percentage) of energy consumption for each kind of industrial establishments of the overall total consumption of energy in industry; cement more than 66%, followed by 13% for sugar ,11% for chemical industries, 5% for textile and 4% for food and Finally engineering industries with 2% share. The weakness of energy consumption in the engineering industry, reflecting the weakness of investment in this sector, particularly from mining and clear this matter further during the follow-up to changes of energy consumption in the industrial sector during the 1995-2005 period, where we find a slight and not proportionate with the needs of sustainable development and increasing population.

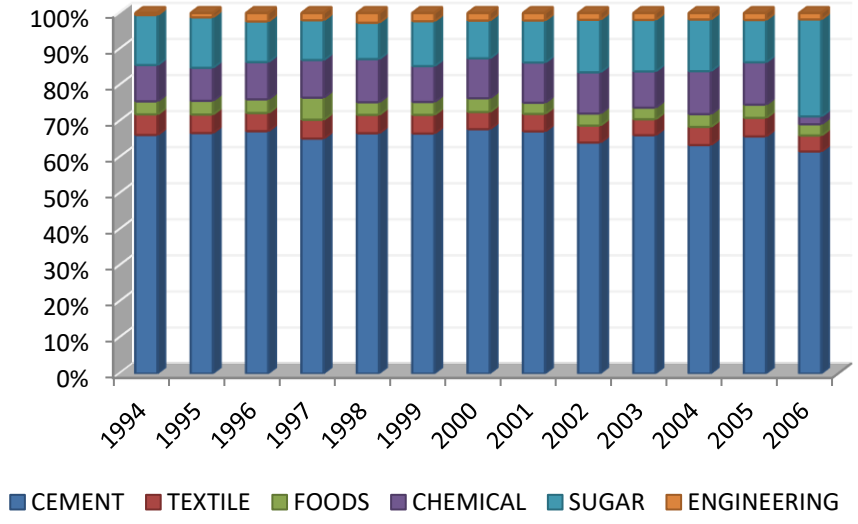

Figure (2) the percentage of energy consumption in each industry

To illustrate the impact of quality of fuel used on the amount of emissions from combustion were calculated the rate of consumption of fuel of the total fuel used in all

sorts of industries and found that, fuel consumption reach up to 97% in each of the cement and sugar industries followed by 86% in chemical industries, then textile 81%, food 52% and 34% in engineering industries table (2)[2], and this indicates that the fuel is the biggest source of emissions in the industry, which is equal in both cement and sugar, followed by chemicals, and this concern should be directed to these industries when we looking for the measures of decreasing the gas emissions.

Table (2), rate of heavy fuel oil consumption to the total fuel consumption

%fuel	Cement	textile	Food	Chemical	Sugar	Eng.
1994	0.97	0.75	0.43	0.85	0.97	0.44
1995	0.97	0.77	0.44	0.86	0.97	0.25
1996	0.96	0.77	0.47	0.87	0.97	0.13
1997	0.96	0.75	0.27	0.88	0.97	0.12
1998	0.97	0.81	0.49	0.89	0.97	0.13
1999	0.97	0.81	0.5	0.84	0.97	0.13
2000	0.97	0.81	0.49	0.84	0.96	0.11
2001	0.97	0.82	0.49	0.84	0.97	0.35
2002	0.97	0.83	0.55	0.84	0.96	0.50
2003	0.97	0.83	0.65	0.86	0.97	0.55
2004	0.97	0.87	0.67	0.89	0.98	0.55
2005	0.98	0.84	0.68	0.87	0.96	0.50
2006	0.98	0.82	0.6	0.82	0.98	0.42

Source (2)

The changes in fuel oil consumption in each sort of industries over the years 1994 - 2006 shows in figure (3), where it appears that there are changes in fuel consumption in sugar, cement, textile and chemical industries, while there is little increase in the consumption of fuel oil in the engineering and food industries due to the dependence of the private sector on it.

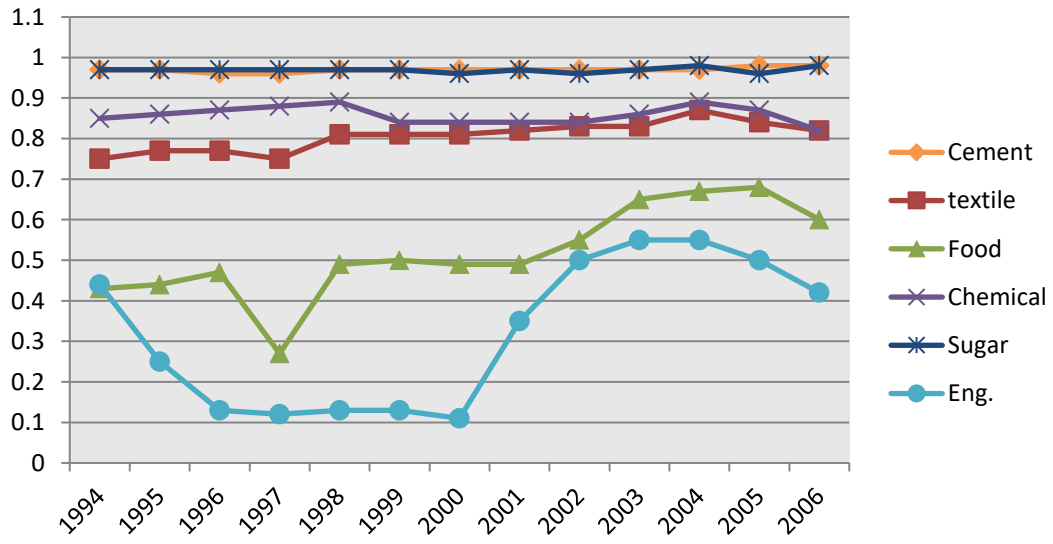

Figure (3) The fuel oil consumption changes between 1994-2006

4. Estimation of gas emissions caused by energy consumption in Industry

The combustion of any type of fuel[3] generates carbon dioxide and methane and nitrogen dioxide and sulfur dioxide and water vapor, etc. Of all these emissions will be interest in the three main gases CO2, N2O, CH4 of the global warming gases, and will be consider the methane and nitrogen dioxide as a carbon dioxide gas [4] (will be converted into CO2 emissions in the GHG emission equations), table (3) clarify the total gas emissions from fuel used in industry during the period between 1994 -2006.

Table (3) gas emissions from using energy in industry

CO2Gg	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cement	1473	1588	1559	1521	1412	1395	1405	1364	1358	1401	1308	1326
Textile	127	122	117	122	108	109	99	98	100	94	104	103
Food	81	91	88	143	74	75	79	63	70	68	73	73
Chemical	224	218	240	244	253	208	230	226	242	213	246	246
Sugar	308	333	261	257	213	261	217	236	309	240	296	224
Engineering	13	29	55	47	57	48	44	43	40	41	37	235

Source (2)

The change of gas emissions from energy use in industry[3] shows in figure (4), where it appears that these emissions has been decreased, especially for the fertilizer industry which can be attributed to the use of other types of fuel, mainly natural gas, which came into use in the beginning of 1998.

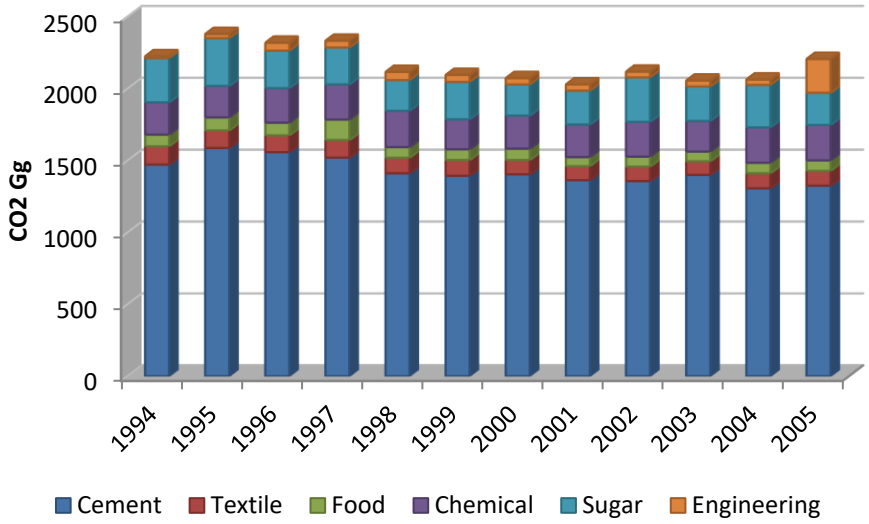

Figure (4) energy emissions changes in industry

5. Energy Emission Distribution

Cement industry is the largest source of emissions from burning fuel, where in the amount of emissions cement of Tartous comes first, followed by Cement of Shahba and then Cement of Aleppo (Table 4) [(4)].

Table (4), emissions of cement industries

co_2Gg	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Public Establish. For Cement	1477	1585	1561	1521	1412	1395	1413	1373	1369	1401	1308	1326
Shahba Cement	390	390	390	390	420	380	390	385	397	407	389	382
Aleppo alarbia cement	216	266	260	257	266	274	289	288	275	289	282	274
Adra Cement	180	202	227	164	10	10	11	12	14	8	6	4
Alrasten Cement	63	63	64	64	65	68	70	67	68	66	65	68
Alsoriah hama	165	170	159	160	163	169	163	175	168	179	159	170
Alarabia hama	17	19	20	20	20	20	16	13	15	13	13	8
Tartous cement	442	472	437	464	466	471	472	431	430	440	395	419

Source (4)

Most of the gas emissions in the chemical industry from Glass Factory in Damascus, Ammonia, Glass Factory in Aleppo and Tires factory in Hama table (5)([4).

Table(5), gas emissions of chemical industries

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Chemical public establish.	224	218	240	244	253	208	230	226	242	213	246	236
Glass – Damascus	73	71	78	77	84	59	71	75	78	82	80	73
Leather	2	2	2	2	1	1	1	1	1	0	0	1
Sar for cleaning – Damascus	8	6	6	6	6	5	4	7	8	2	2	4
Tamico Damascus	2	2	2	2	2	2	2	2	1	2	3	2
plastic alahliah – damascus	3	3	2	2	1	1	1	1	1	1	1	1
Tires -hama	26	26	24	28	25	21	19	22	23	22	25	11
Glass –Aleppo	50	49	27	49	43	50	48	53	53	33	56	53
Electrical Lamp-Aleppo	2	3	0	0	0	0	0	0	0	49	53	62
Fertilizer-katinah	57	54	96	70	82	64	75	57	63	47	53	50
Paper - Diralzour	0	0	0	5	6	4	8	6	14	19	24	27

Source (4) [2]

The most emissions of engineering industries are coming from Melting Scrap in Hama and wood in Damascus, table(6)[4]

For Engineering Industries, most of the gas emissions come from the General Company Iron and Steel products in Hama and Wood factory in Damascus, table (6)[(4)].

4) - Study of greenhouse gas inventories in the industrial sector, the United Nations Program 1994-2005

[5]Table(6), gas emissions of engineering industries

CO2 Gg	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Eng. Public establish.	13	29	55	47	57	48	44	43	51	0	37	32
Barada – Damascus	1	0	1	0	1	1	1	1	3	0	2	3
Public Est. for manufacturing	0	0	0	0	0	0	0	0	6	0	5	6
sulfur – Damascus	5	5	4	4	3	3	1	0	40	41	37	0
Batteries – Aleppo	0	2	2	2	6	2	1	2	1	1	0	0
Iron – Hama	0	11	34	29	36	30	30	31	0	0	0	0
Wood - Latakia	3	2	4	3	4	3	2	4	1	1	0	0
Metal construction	1	0	0	0	1	0	0	0	29	29	1	1
Cables _Aleppo	0	2	1	0	1	2	2	2	15	20	30	32
Alforat _Aleppo	0	2	3	3	1	3	2	1	0	7	0	18

Source (4)

In the textile industry the most gas emissions came from Alkhomasieh company in Damascus, the United Arab Company in Damascus.

For the food industry the most gas emissions come from the Industrial Company for Vegetable Oils - Aleppo and Al Chark (Orient) Food Products company in Aleppo.

[3]6- Syrian Industrial processes emissions:

There are another sources of industrial emissions not related to energy but come from changes in the physical and chemical materials for industrial processes, and these emissions depend on the amount of production and emission factor(1). To facilitate estimation of emissions from industrial processes has been divided into four areas, as contained in IPPU at 1996, the statement was available to industries in Syria and on the three main greenhouse gas emissions CO2, N2O, CH4.

Extractive industry: This includes production of cement, lime production, use of limestone, the production and use of sodium carbonate, asphalt surfaces and road paving, the production of glass and pumice stone. In Syria, many of the raw materials are available that encourage manufacturing, and the most important is the limestone raw material for cement and lime production , in addition to the asphalt, glass and the use of sodium carbonate[6].

Chemical industry: This includes the production of ammonia, nitric acids, adipic acid, urea, carbides, Alkrbulaktam and petrochemicals. Reflect the chemical industry in Syria, the most important two industries are: fertilizer industry and oil refining industry.

Metal production: Include Iron, Steel, Ferroalloys, Aluminum, Magnesium and other metals. In Syria no mining industry for producing different metals from its raw materials, but there is a factory for smelting iron scrap which has some emissions, and there are various other public and private industries especially for formation of imported aluminum and this does not make any emissions[4].

[5]**Other Industries:** Include paper, production of food, beverage production, production and use of halocarbons and other sources. In Syria there are many of manufacturing industries regarding food products in both the public and private sectors, such as race, wine, beer and other alcoholic beverages, bread, sugar, biscuits and butter and fats, and the gas emissions of these industries are contributing in the global warming [(1)].

Table (7), shows the amount of material produced from raw material industry, chemical and metal industries in Syria [4,6] ,and their emissions within the three main gases CO_2, N_2O, CH_4.

Table (7), the quantity production of industrial process (ton)

	Material industry		Chemical industry			Metal industry
year	**Cement** t*1000/y	**Soda ash** t/y	**Nitric acid** t/y	**Ammonia** t/y	**Coke** t/y	**metal** t/y
1994	4344	16063	66952	112150	153939	35866
1995	4804	15792	59985	77190	148118	33144
1996	4817	24274	78705	97850	129228	60104
1997	4838	24801	72283	101785	126232	52532
1998	5016	24007	58977	157200	74189	59515
1999	5134	24700	66991	136000	70000	51830
2000	4631	25141	83138	110859	93850	53334
2001	5428	26275	72943	168332	97698	60055
2002	5399	29259	64702	173736	72539	48880
2003	5224	27220	80503	161045	78200	58326
2004	5098	27879	64702	140245	109288	72705
2005	5218	24606	77061	145950	105115	75130

Source (2)

7- Emissions from industrial processes

Industrial Processes emit different kinds of gases as CH4, CO2 ,N2O, CO, N2O, SO2, NOX, NMVOC. The three main gases which are concerned with the phenomenon of global warming: CH4, CO2, N_2O and the kind of the gas emissions from each industry are as follows(1):

- Cement industry (all cement factories and soda ash use) emit CO2.
- Chemical industry (ammonia ,nitric acid, coke, soda ash) emit CO2, CH4, N2O.
- Metal industry (scrap smelting factory) emits CO2 and other gases.

Table ([8][5])[(4)] illustrates Syrian industries included in each sector and the amount of emissions as a carbon dioxide (CO2), (after the conversion of methane gas and nitrous oxide to carbon dioxide[(3)]) where, it seems that the biggest source of greenhouse gas of carbon dioxide is in the cement industry followed by, chemical and metal[(4)] industries.

Table (8), emissions from industrial processing as CO2

	Cement	chemical				Metal
Gg co_2	**Cement**	**ammonia**	**Nitric acid**	**Soda ash**	**coke**	**Ferrous**
1994	1994.0	168.23	81.05	6.67	1.77	57.39
1995	2394.8	115.79	72.61	6.55	1.70	53.03

1996	2401.3	146.78	95.27	10.07	1.49	96.17
1997	2411.7	152.68	87.50	10.29	1.45	84.05
1998	2500.5	235.80	71.39	9.96	0.85	95.22
1999	2559.3	204.00	81.09	10.25	0.81	82.93
2000	2308.6	166.29	100.64	10.43	1.08	85.33
2001	2705.9	252.50	88.30	10.90	1.12	96.09
2002	2691.4	260.60	78.32	12.14	0.83	78.21
2003	2604.2	241.57	97.45	11.30	0.90	93.32
2004	2541.4	210.37	78.32	11.57	1.26	116.33
2005	2601.2	218.93	93.28	10.21	1.21	120.2

[4]Source (6)

Figure (5), shows changes in emissions of industrial processes during the period between 1994-2005, where it is clear that the variations is small because the operation is at maximum production capacity and tend to increase due to the developments of the industrial sector recently, but the amount of emissions is put cement industry at the first, followed by the chemical and engineering industries.

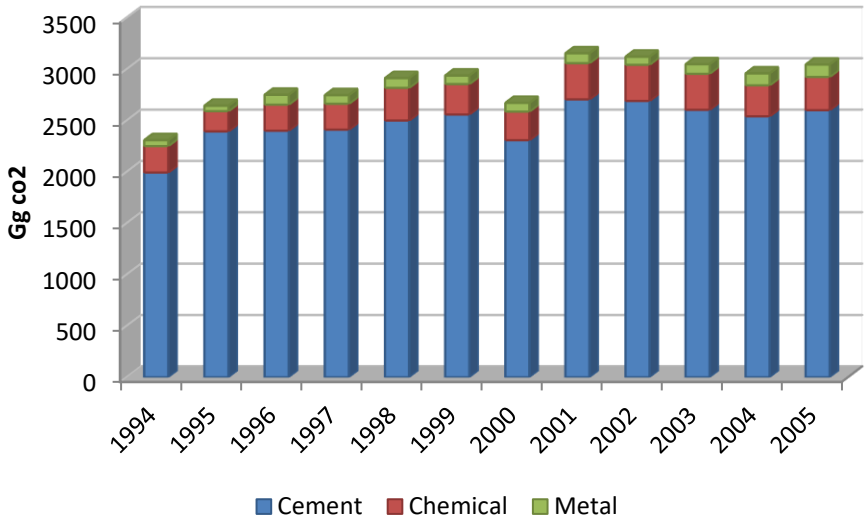

Figure (5) emissions changes of industrial processes

Figure (6) summarize the percentage contribution of each sort of the three industries in the emissions of the total greenhouse emissions due to the industrial activities and illustrates changes rates during the period between 1995-2005, which shows that the emissions from the cement industry, reach up to 85%, 17% for chemical and 3% for engineering, and the emissions of cement is decreasing due to the improvement of the production techniques or to decrease the amount of production, while the quantity of emissions of the chemical and engineering industries increased as a result of the development in these industries.

4) - Study of greenhouse gas inventories in the industrial sector, the United Nations Program [4] 1994-2005

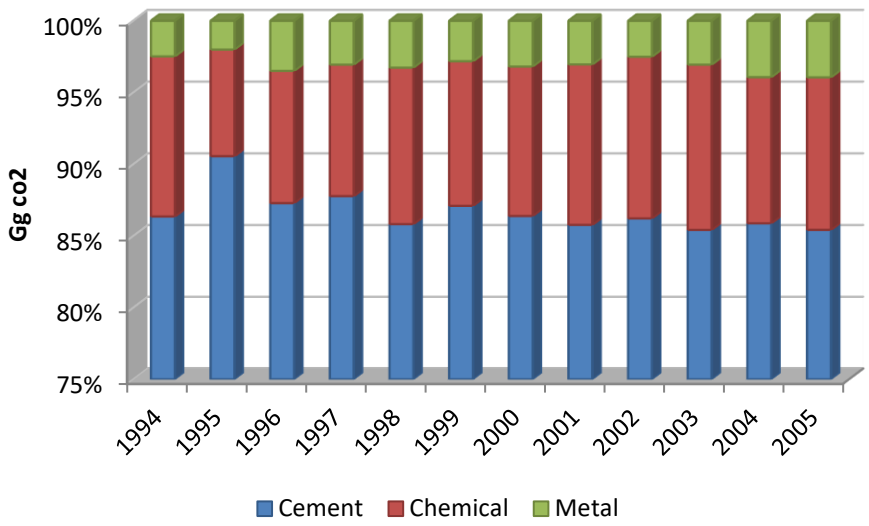

Figure (6) percentage of industrial processing emissions

8- Total Industrial Emissions

After the emissions has been estimated from both fuel combustion and those of the industrial processes. Table(9), clarifies the total industrial emissions and the contribution of both of them. It has been focused on the cement industry, chemical and engineering industries, which has two sorts of emissions, while the textile industry, food and sugar industries it has emissions only from burning of fuel.

Table (9), total industrial emissions

CO_2 Gg		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cement	Energy	1473	1588	1559	1521	1412	1395	1405	1364	1358	1401	1308	1326
	Process	2165	2395	2401	2412	2500	2559	2309	2706	2691	2604	2541	2601
	Total	3639	3982	3960	3933	3913	3954	3714	4070	4049	4005	3850	3927
	%energy	0.40	0.40	0.39	0.39	0.36	0.35	0.38	0.34	0.34	0.35	0.34	0.34
Textile	Energy	127	122	117	122	108	109	99	98	100	94	104	103
Food	Energy	81	91	88	143	74	75	79	63	70	68	73	73
Chemical	Energy	224	218	240	244	253	208	230	226	242	213	246	246
	Process	258	197	254	252	318	296	278	353	352	351	302	324
	Total	482	414	493	495	571	504	508	579	594	564	548	570
	% energy	0.47	0.53	0.49	0.49	0.44	0.41	0.45	0.39	0.41	0.38	0.45	0.43
Sugar	Energy	308	333	261	257	213	261	217	236	309	290	296	224
Eng.	Energy	13	29	55	47	57	48	44	43	40	41	37	35
	Process	57	53	96	84	95	83	85	96	78	93	116	120
	Total	70	82	151	132	153	131	129	139	118	134	154	155
	% energy	0.18	0.35	0.36	0.36	0.38	0.37	0.34	0.31	0.34	0.30	0.24	0.23

Source (4,7)

Figure (7), illustrates the amount of total industrial emissions and its distribution on the deferent sorts of industries, where it is clear that the largest contributor to emissions is in the cement industry followed by chemicals, sugar, engineering, textiles and food industries.

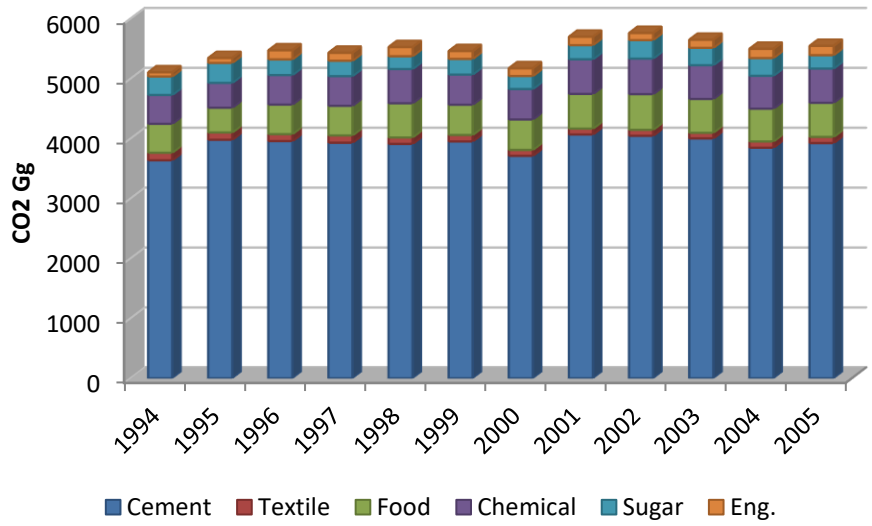

Figure (7) total industrial emissions distributed on industrial utilities

Figure (8), shows the proportion of emissions from both energy and industrial processes where it appears that emissions:

In the cement industry, 65% resulting from industrial processes and 35% from energy. In the chemical industry 55% resulting from industrial processes 45% from energy. In the engineering industry 65% resulting from industrial processes and 35% from energy. In other words, in the industrial sector emissions from industrial processes is greater than emissions from burning fuel (energy use)[6].

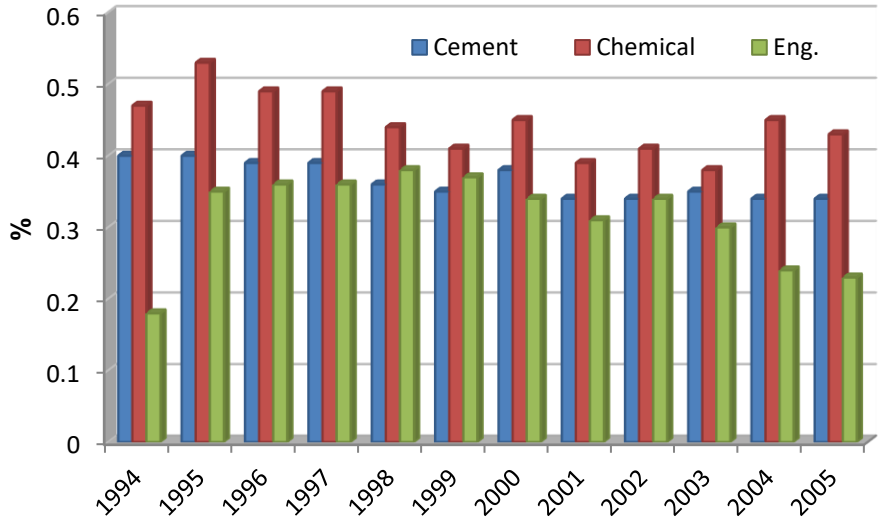

Figure (8) the proportion of energy emissions of total industry emissions

The changes amount of the total industrial emissions during the period 1994-2005, is clarified in figure (9), where it appears that the difference between the amount of emissions from energy and from industrial processes are two small during 1994-1997, and decreasing the amount of emissions from energy in the recent years, this is due to the development of some industrial sectors such as chemical, engineering, sugar asnd food industries, and low energy emissions due to the improvement of the quality of fuel combustion techniques or by the using of natural gas instead of heavy fuel oil..

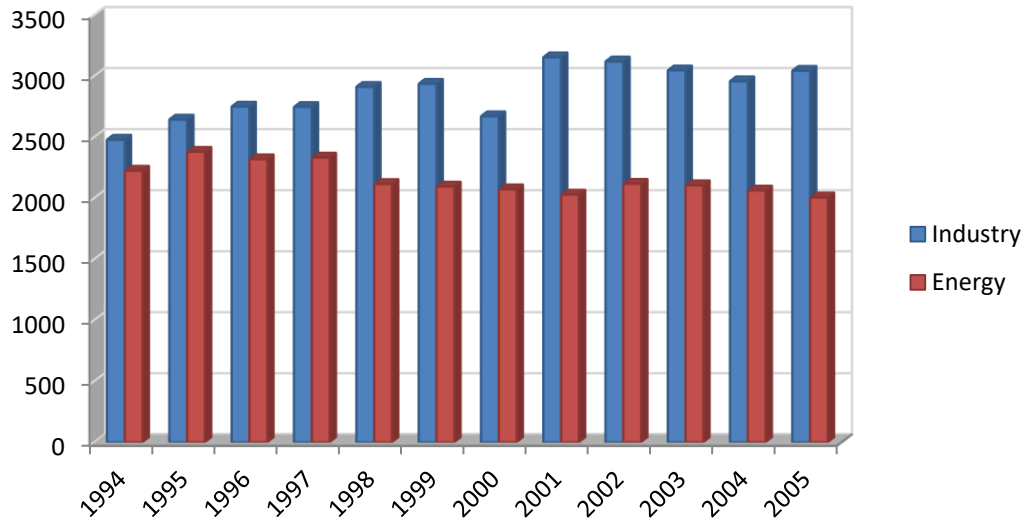

Figure (9) the changes of total industrial emissions

The contribution percentage of emissions of the industrial processes and the emissions from energy use is shown in figure (10), which shows the amount of emissions from industrial processes, can be reach up to (55-62%) of the total emissions.

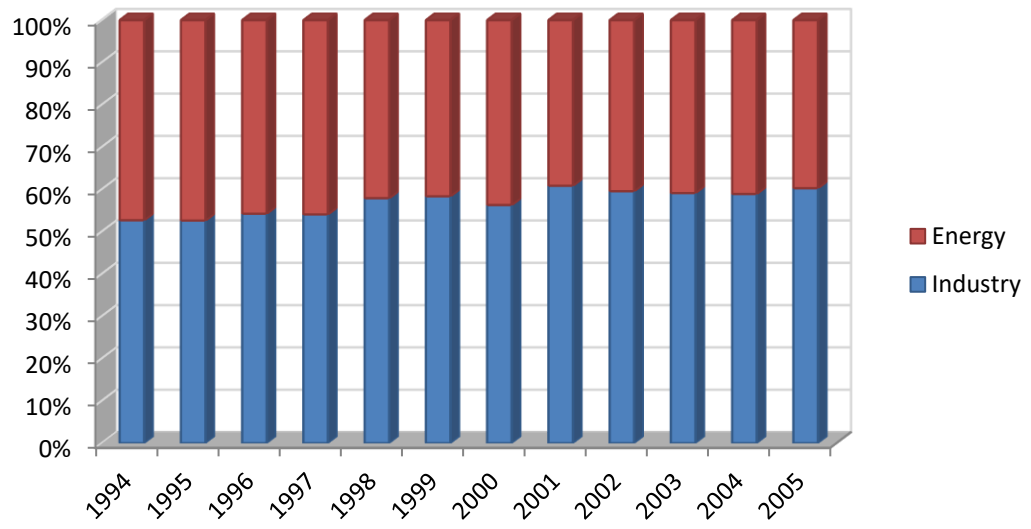

Figure (10) the percentage of industrial processes emissions

9. Emissions mitigation from industrial sector

The study shows the emissions cause by the industrial sector from both energy uses and industrial processes, where 40% of emissions come from fuel and 60% come from industrial processes, so the mitigation measures should address both sides but that the mitigation in the area of energy sector has wider choices than in industrial processes because the second one controlled by the way of production (production method).

9.1 Actions on mitigating emissions from industrial processes:

Carbon dioxide (CO_2) emissions come from cement industry, iron and ammonia industries and the use of sodium carbonate. Nitrogen dioxide emitted from the production of nitrogen acid and methane emitted from petroleum coke. The amount of emissions proportionate with the amount of production and emission factor for each kind of industry, because the control of the amount of emissions is in the chemical reaction process and industrial production method, therefore must be such emissions, but it can be reduced by making use of it, by using the heat recovery measure to pass the gas emissions through the heat exchanger to heat the need water for the industrial processes or the necessary air used to burn fuel in the furnace…etc, then gas can be injected and stored underground, or purification of gas passed through the absorbing liquids...etc.

9.2 Emission mitigation measures in the energy consumption in industry:

Energy conservation and energy efficiency measures classified into three groups which are[7]: low-cost, medium cost and high-cost measures, the industrial utility can choose the measure according to their priority or implementing all of the needed measures whenever it is feasible. The low cost measures can be achieved by the cooperation with workers and give incentives for energy conservation and energy efficiency implementation in the utility and that can encourage them to save energy.

9.2.1. Low cost action

These measures can be implemented through the use of existing equipment efficiently and focus on measurements, control and maintenance in the utility such as installing control devices and switching off the equipment when it is not in use.

- In thermal equipments (maintenance and control) [7]:

Adjust and control combustion (ratio of fuel to air), control of the feed water and blowdown water from the boiler, regular cleaning of the surfaces of heat exchangers, maintenance of the hot water pipes insulations, water quality monitoring and steam leak detection.

- In electrical equipments (maintenance and control):

A - Electricity and distribution network

Optimal transformer loading, run the owned diesel generator in times of peak period, use of the day light and turn off unnecessary lights, load control, and manage the working shifts to reduce the maximum demand…etc.

B) Cooling and air-conditioning systems

Adjust the temperature and humidity accurately as needed, regular maintenance, setting the temperature of cold water, improve the performance of cooling towers, use of timers and

sensors in special places, prevent leakage of hot air to the air-conditioned places and adjust air treatment (purification) units..etc.

C) Compressed air network

Adjust the air pressure according to the need, adjust compressors loading, Use the out-side cool air instead of the surrounded warm air, Waste heat recovery, Maintenance, prevent air leakage losses…etc.

9.2.2. Actions of low /medium cost:

These actions represent a use of technologies in finding solutions and the technicians have an important role in these measures, for examples: insulations and taking the measurements and control systems installation.

- Thermal Systems (equipments and networks)[7]

Boilers and steam distribution networks:

Replacement of burners, using of combustion efficiency monitoring equipments, using the hot air resulting from the exhaust air in the process of pre-heating, insulation of the boiler and steam pipes, fittings and use the lowest possible diameters of pipes to reduce heat loss and the installation of suitable traps for steam, vapor recovery from the condensate water, generation of low vapor pressure from the high pressure liquid, and take advantage of the high temperature resulting from the hot water that feeds the boiler.

- Electrical systems (equipment and networks)

A - Electricity distribution networks

Improve the load factor to reduce the cost of electricity, improve power factor by installing capacitors, installation of maximum demand control systems, loads off-peak periods as much as possible, take advantage of the existing electrical tariff and the replacement of lighting systems with more efficient.

B– Cooling and air-conditioning systems

The maximum possible improvement to the multi-stage cooling system, change the rate of flow of cold water as needed, use of enthalpy system (enter the appropriate air rather than "hot air resulting from air conditioning) and the option of the cooling water tank to the freezing point to meet demand at peak.

C - Compressed air system

Improve the distribution network of the compressed air, use of a multi-stage compressor with internal cooling, use storage tanks for compressed air to avoid the unstable load.

D - process improvement

Replacement of existing motors with more efficient one or with high efficiency motors, using variable speed drives and heat recovery systems…etc.

9.2.3. High-cost measures

These measures rely on technology to save energy consumption and should be done a feasibility study before taking the decision to implement this set of actions with high investment costs and this measures rely on the use of new technologies or changing of production processes.

New technologies like:

- Use of co-generation

- Installing a backup generator for use at peak times

- Use of high efficiency equipments and motors and its applications like: high efficient air compressor, fan, pumps, converters, transformers... etc..

- Use of new technologies for alternative energy (oil, gas, electricity)

- Use of renewable energy sources.

Summarize of the most common actions and measures for Energy Conservation and Energy Efficiency can be done in the industrials utilities:

1- Operational Equipment efficiency

- Boiler air/fuel ratio control
- Adjust burners for optimal air/fuel ratio
- Monitor boiler efficiency and improve control capability
- Use warm air for combustion air
- Preheat combustion air with waste process heat
- Preheat boiler make-up water with exchange from waste process heat
- Fuel atomization improvements
- Heat oil proper temperature for good atomization
- Use air instead of steam for oil atomization
- Minimize boiler blowdown with better feed water treatment

2- Equipment Maintenance & Replacement

- Boiler maintenance
- Establish burner maintenance schedule
- Keep boiler tubes clean, both fireside and waterside
- Replace obsolete burners with more efficient ones
- Replace obsolete boiler

3- Combustion Heat Recovery

- Heat recovery from flue gases for boiler operations
- Use waste heat from hot flue gases to preheat combustion air
- Use waste heat from hot flue gases to preheat boiler feed water
- Use waste heat from hot flue gases to preheat wastes for incinerator
- Install waste heat boiler for process steam

- Use waste heat from hot flue gases to preheat products or materials going into ovens, dryers, etc.
- Use waste heat from hot flue gases to heat process or service hot water
- Recovery heat from hot flue gases for space heating
- Recover heat from boiler blowdown to preheat boiler feed water

4- Combustion Heat detection

- Insulation of boilers, burners
- Repair poor insulation in boilers, kilns, furnaces, etc
- Install boiler insulation, or upgrade to optimal thickness
- Furnace openings
- Reduce size of charging openings, doors, etc
- Repair kiln doors so that they seal efficiently
- Install automatic stack damper

5- Steam

- Upgrade/repair steam trap
- Install steam traps
- Use correct size steam traps
- Repair or replace faulty or leaky steam traps
- Shut off steam traps on superheated steam lines when not in use
- Condensate return system
- Increase amount of condensate returned; e.g. increase pressure, repair leaks
- Install, upgrade or repair insulation on condensate lines
- Install, upgrade or repair insulation on steam lines
- Repair and eliminate leaks in steam lines and valves
- Repair and eliminate steam leaks at high-pressure reducing stations
- Repair and eliminate steam leaks at process equipment
- Use of steam condensate
- Return steam condensate to boiler plant
- Use minimum necessary operating steam pressure

6- Electricity

- Optimize power factors
- Install demand controller/load shredder

- Install power factor controllers on motors
- Optimize motor size with load; size motors for peak operating efficiency
- Use multiple speed motors or variable speed drives for variable pumps, blowers, and compressors loads
- Transformers, conductors and other electricity-handling equipment
- Compressed Air
- Reduce use of compressed air
- Reduce the pressure of compressed air system to the minimum required
- Shut off cooling when outside air will cool process streams/equipment
- Replace compressed air cooling with water cooling
- Coolest air to compressor intake
- Install compressor air intakes in coolest locations
- Use heat exchange to cool air intake to compressor
- Eliminate leaks in lines and valves
- Remove or close of unneeded compressed air lines to eliminate leaks

7- Equipment Scheduling

- ✓ Equipment shutdown
- ✓ Shut down process heating equipment when not in use
- ✓ Turn off conveyors when not in use
- ✓ Use most efficient equipment at its maximum capacity and less efficient equipment only when necessary
- ✓ Schedule to run equipment with full loads
- ✓ Minimize operation of equipment required to be kept in standby condition

8- Plant Schedule

- ✓ Plant operation schedule changes
- ✓ Consider shifting from daytime to nighttime operations
- ✓ Maintenance scheduling
- ✓ Schedule routine equipment maintenance during non-operating periods

9- Water

- ✓ Recovery of water
- ✓ Recover and reuse cooling water-cooling tower, etc.
- ✓ Eliminate leaks in water lines and valves
- ✓ Remove or close off unneeded water lines to avoid potential leaks

- ✓ Use flow control valves on equipment to optimize water use
- ✓ Minimize water use in lavatories by using appropriate fixtures and valves
- ✓ Monitoring of water use

10- Techniques Related to Certain Processes

- ✓ Minimize non-essential material in heat treatment process
- ✓ In batch firing, use kiln "furniture" designed specifically for the job
- ✓ Convert from indirect to direct firing in ovens, furnaces or kilns
- ✓ Use direct flame impingement or infrared processing for chamber type heating
- ✓ Modify dye beck for efficiency improvement (textile)
- ✓ Improve textile dryers
- ✓ Refrigeration and cold storage
- ✓ Use optimum thickness insulation for low temperatures
- ✓ Cool smallest space necessary for refrigerated storage
- ✓ Repair refrigerator door seals

11- Process Heat Recovery

- ✓ Heat recovery from exhaust or effluent streams for process use
- ✓ Recover heat from hot waste water
- ✓ Recycle hot process exhaust air, or exchange heat with incoming air
- ✓ Use exhaust steam for process heat
- ✓ Use exhaust gases to preheat makeup air

12- Process Heat detection

- ✓ Insulate bare tanks, vessels, lines and process equipment
- ✓ Increase insulation thickness on process tanks, vessels, lines and equipment
- ✓ Cover open tanks with floating insulation
- ✓ Cover and seal open tanks
- ✓ Use minimum necessary ventilation to drive off combustible solvents or other unwanted vapors
- ✓ Use outside air instead of conditioned air for process purposes-drying, etc

13- Lighting

- ✓ Reduction in general lighting
- ✓ Disconnect fixtures, remove lamps, or use lower output lamps to achieve minimum necessary light levels
- ✓ Reduce lighting where natural light supplements indoor lighting

- ✓ Reduce exterior lighting to minimum safe level
- ✓ Provide strong lighting only where tasks are performed
- ✓ Clean light fixtures regularly to permit use of lower output lamps
- ✓ Rewire to permit turning off lights in little used areas, while other lights remain on
- ✓ Rewire to permit turning off lights where natural light is sometimes sufficient
- ✓ Manually turn off lights in areas not in use
- ✓ Eliminate lighting above high storage stacks
- ✓ Use higher efficiency, lower power lamps in existing fixtures
- ✓ Convert to more efficient light source

14- Alternate Fuels

- ✓ Process heat supplied by alternate fuels
- ✓ Install solid waste incinerator for process heat
- ✓ Burn wood by products for process heat
- ✓ Burn wood by products for space heat

15- Conversion to More Efficient or More Economical Fuel

- ✓ Conversion to combustion of a different fuel
- ✓ Convert oil-burning to natural gas combustion
- ✓ Replacement of electrical equipment with equipment burning fossil fuels
- ✓ Replace electrically operated process heating equipment with fossil fuel combustion equipment

16- Solar Energy

- ✓ Solar heat
- ✓ Use solar heat to heat domestic or service hot water
- ✓ Use solar heat for process heat

10-Mitigation measures for energy consumption in the industry

Energy balance calculations in Syria indicated that the industry consumes an average of about (18%) per annual of the total final energy consumption of about 23 million tons of oil equivalent [8] at 2008. Where the largest share goes for the domestic consumption, which reaches about (30%) and transport sector, which consumes about (20%), it is necessary to focus on the industrial sector to reduce its consumption of energy, rationalize (conserve) and improve its efficiency, try to use of the new and renewable energy applications which, it is very useful to focus on industries with the largest consumption of energy such as manufacturing cement, chemical, engineering and textile without compromising quality

and thus reduce the energy consumption and reduce the greenhouse-gas emissions resulting [7].

The detailed audit studies including the related measurements and calculations carried out by the Ministry of Electricity (SSEECP) project showed that there are several opportunities for energy conservation and energy efficiency improvements in some cement plants and construction materials which can be divided into:

• Thermal opportunities dealing with conservation opportunities for the use of steam systems ,control the efficiency of combustion in furnaces and boilers, adjust the boilers operation and heat recovery , change the heating fuel tanks systems and improving the efficiency of thermal insulation (improve the insulation of hot water pipes and steam pipes and the walls of furnaces and boilers) ... etc.

• electrical opportunities dealing with the development of the production line and improving the energy efficiency by adding an especial control systems, to the production line which can gives savings in the energy consumption, installation of the capacitors , improve the power factor for electric transformers , use of energy saving lamps (CFL) instead of incandescent lamps ,improve the efficiency of the air compressors, and apply the energy efficiency measures in the motors and use of high efficiency motors , apply the energy demand measures including load management and displacement outside the peak period etc.

Table No. (10)[7] shows some energy efficiency and energy conservation opportunities to improve the thermal energy and reduce the consumption rates in some industries and calculate the annual energy savings of the total oil consumption by Ton of Oil Equivalent per year (TOE/yr).

Table.(10)[7] some energy efficiency and energy conservation opportunities to improve the thermal energy:

	Adjust combustion ton/yr	**Pipes insulation ton/yr**	**Furnaces insulation ton/yr**	**Steam recover ton/yr**	**Steam use ton/yr**	**Heat recover ton/yr**	**Stop steam lack ton/yr**	**Adjust boiler operation ton/yr**	**Change heating system ton/yr**	**Total save ton/yr**	**Total save TOE/yr**	**S.P./yr**
Textile	1176	1871	2144	252	501	200	520	2200	396	9455	9077	56,876,432
Food	488	621	33	1001	78	39	172	605	155	3207	3212	21,074,334
Chemical	3842	302	8820	2	0	172	109	0	10	13257	12846	77,491,084
Sugar	161	453	0	44	0	0	0	0	0	679	691	4,982,687
Engineering	78	0	78	0	0	89	0	0	0	245	241	1,475,746

Source (7)

Table No. (11)[7] shows some energy efficiency and energy conservation opportunities to improve the efficiency of the electrical power and reduce its consumption rates in some industries and calculate the annual energy savings by Ton of Oil Equivalent per year (TOE/yr).

Table.(11) some energy efficiency and energy conservation opportunities to improve the efficiency of the electrical power

Total save due to Energy Efficiency and Energy conservation opportunities							
	Lighting system	Motors	Transformer loading	Electrical control	Total		
Company name:	KWh	KWh	KWh	KWh	KWh/yr	TOE/yr	S.P./yr
Cement	165064	124670	0	25320000	25903549	2228	65,036,928
Textile	2210310	1447481	952084	43200	4939467	425	35,899,848
Food	128899	0	28966	76260	401325	35	2,859,729
Chemical	687324	609173	103931	5300	2177924	187	24,835,629
Sugar	344556	280133	0	0	624689	54	6,463,752
Engineering	846526	45000	0	0	975622	84	7,395,880
Milling	458864	695608	0	198500	1954260	168	6,876,077
Ministry of Agriculture	1380213	265523	0	105405	1751141	151	10,076,705
Ministry of Health	1772258	0	689472	0	2490930	214	14,387,409
Ministry of Construction	56409	922593	0	0	1024350	88	10,603,026
Ministry of Economy	46178	126784	60269	0	233231	20	1,302,290
Gov. utilities	706920	69200	21146	173700	1568836	135	4,766,527
Private sector	362355	0	0	0	377907	33	1,501,101
Total	9,165,876	4,586,165	1,855,868	25,922,365	44,423,230	3,820	192,004,900

Source (6)

The total energy savings from both electrical and thermal opportunities and other opportunities and its percentage, table (12)[9] shows that the biggest savings can be done in the cement sector which is about 25% of the total savings and which equal to 435$ million SYP followed by chemicals, textile and food industry.

Table (12)[7] total savings from both electrical and thermal opportunities

Company name:	**Electrical opportunities S.P.**	**Thermal opportunities S.P.**	**Other opportunities S.P.**	**Total S.P.**	**Total %**
Cement	11,202,390	12,587,730	84,522,034	108,312,154	**24.85%**
Textile	32,669,313	40,553,612	36,206,506	105,003,289	**24.09%**
Cotton	673264	441218	-	1,114,882	0.26%
Food	2,178,664	18,471,689	7,991,223	28,641,576	**6.57%**
Chemical	22,632,062	25,830,390	57,137,883	105,600,334	**24.23%**
Sugar	6,463,752	5,705,098	-	12,168,850	2.79%
Engineering	7,185,640	1,046,871	881,515	9,114,026	2.13
Ministry of Agriculture	9,813,192	343,000	335,722	10,491,914	2.41%
Ministry of Health	12,590,729	4,108,146	2,902,251	19,601,126	4.50%
Ministry of Construction	10,489,656	6,905,520	113,370	17,508,546	4.02%
Ministry of Economy	1,151,617	-	191,223	1,342,840	1.68%
Gov. utilities	2,784,737	789,841	1,000,480	4,575,058	1.05%
Private sector	1,462,221	1,606,356	3,128,652	6,197,229	1.42%
Total	125,500,581	118,424,653	196,372,544	435,871,636	1oo%

source(7)

Implementation of the available thermal and electrical opportunities will enable the industrial sector to recover a big part of lost energy, which costs a lot of money and can be recovered with some simple procedures and measures and much of the Administrative Instructions, it was shown, for example, that in case the implementation of the thermal opportunities in the cement industry, it could provide 5-20%, and in the case of the implementation of the electrical opportunities it is possible to save more than 10% of the total electrical consumption of the facility without any cost for some opportunities like (adjust the combustion efficiency in furnaces and boilers...etc.) and within small cost to some others with small payback period does not exceed a few months.

11. Economical and Environmental Impacts of the Mitigation Measures

Energy savings have been calculated resulting from implementation of some thermal and electrical measures in cement utilities show that it can provide about 23000 tons of oil equivalent annually, at a minimum by the implementation of thermal opportunities, and about 11000 tons of oil equivalent per year by the implementation of electrical opportunities, and thus the total reduction in the amount of carbon dioxide is about 109000 tons of CO2 equivalent annually, which about 7% of the total annual CO2 emissions of cement utilities.

The detailed energy audit studies of fertilizer plant indicates that the ammonia urea plant in Homs has an opportunity to increase efficiency for controlling (adjusting) combustion in boilers and furnaces, as well as insulation pipes for boilers and furnaces, where it can be save about 434 tons of oil equivalent of natural gas annually and to avoid emission of about 1128 tons of CO2 equivalent per year.

The implementation of thermal insulation in the cement sector will provide about 1.5 million SYP with the cost of the implementation does not exceed 18% of the recovered amount and with payback period not exceeding two months, table (13) explain the savings from the implementation of the thermal insulation of pipes and using an efficient lighting lamps in certain industries and the implementation cost and the payback period.

Table (13) the cost of implementation and payback period by some mitigation measures

The total save and the payback period due to insulation opportunities				**The total save and the payback period due to efficient lighting lamps opportunities**		
Company name:	**Total save from pipes insulation S.P.**	**Cost S.P.**	**Payback period. month**	**Total save from efficient lighting lamps S.P.**	**Cost S.P.**	**Payback period month**
Cement	1,327,157	243,380	2	2,933,378	3,227,000	13
Textile	24,448,043	1,996,300	1	5,659,918	2,422,600	5.14
Food	4,206,352	934,045	3	384,879	89,110	2.78
Chemical	1,984,768	1,324,560	8	1,556,167	538,000	4.15
Sugar	2,725,580	578,700	3	689,112	273,000	4.75
Engineering	491,621	190,000	5	2,186,160	1,929,200	10.59
Ministry of Health	957,741	135,452	2	5,512,166	4,793,650	10.44
Private sector	1,333,823	149,500	1	611,189	326,900	6.42

Source (7)[11]

Table No. (14) summarized the results of the detailed Energy Audits studies, conducted by the Ministry of Electricity (SSEECP) project on some industries with high consumption of energy sources as an cement ,chemical, engineering and textiles industries in the past few years, which showed rates of savings in the consumption of fuel and diesel compared with the average total consumption of the utility and the corresponding of emissions reduction of gas that can be achieved if the energy conservation and energy efficiency opportunities7 have been implemented. The Estimated energy savings which can be achieved by the implementation of thermal opportunities in the cement industry about 21000 tons of oil equivalent, which represented more than 6% of total consumption, and a corresponding emissions reduction of 65000 tons of CO2 equivalent, and in the chemical industry is estimated at about 10000 tons of oil equivalent, which represented more than 13% of the total consumption and the corresponding emissions reduction of 31000 tons of CO2 equivalent, and in the engineering industry up to about 900 tons of oil equivalent, which represented more than 7% of the total consumption, and a corresponding emissions reduction of approximately 2800 tons of CO2 equivalent, and in the textile industry can be at least of about 5700 tons of oil equivalent, which represented more than 19% of the total consumption, and the corresponding emissions reduction of about 17900 tons of CO2 equivalent.

Table (14), percentage of fuel and diesel savings for some industries

	Cement	**Chemical**	**Engineering**	**Textile**
Diesel consumption –ton	10426	8560	5200	4828
Fuel consumption –ton	418972	71738	6689	25618
Average fuel save%	**4.9**	**15**	**10**	**20**
Average diesel save %	**11**	**5**	**5**	**20**
Average fuel save ton/yr	20530	9326	669	5000
Average diesel save ton/yr	1146	1113	260	965
Total save (TOE)	20878	10088	907	5784
Total CO2 emissions (Million ton) in average	1.308	0.246	0.04	0.1
Total co2 emissions save (ton) in average CO2	64722	31273	2811	17931
percentage of co2 save% in average	**6**	**13**	**7**	**19**

Source (7)

Thus the savings on the annual total consumption by Tone Oil Equivalent (TOE) and the corresponding emissions reduction of gas is in accordance with Table No. (15) where it can achieve savings in the consumption of petroleum derivatives (energy resources) used in the heat consumption due to the implementation opportunities for improving the energy efficiency proposed by between 5 - 20% and savings can be up sometimes to 25% of the heat consumption of the utility and thus achieve the emissions reduction almost the same proportions by type of fuel used. And that the savings results from the implementation of mitigation opportunities can be provided about 400 thousand TOE per year, and a corresponding emissions reduction of about 1.2 million tons of CO2 equivalent of the total consumption of the industrial sector, as the savings achieved is 11% of total consumption on average.

Table (15) savings in the annual total consumption and the corresponding emissions reduction:

Kind of Industry	Average total consumption TOE	Total save TOE /yr	Total avoid emissions of CO2 TOE/yr
Textile	**34030**	**(%25) 9077**	**28138**
Food	**25444**	**3212(%12)**	**9957**
Chemical	**73084**	**12846(%17)**	**39823**
Sugar	**82995**	**691(%1)**	**2142**
Engineering	**12870**	**241(%2)**	**747**
Average total consumption	**228423**	**(%11) 26067**	**80807**

Source (7)

12. Future Vision to reduce emissions from industry sector

The estimated average growth rate in the annual industrial consumption up to 2030 is about 6% so it is expected that the final consumption of energy resources is about 17,8 million tons of oil equivalent and therefore it is possible to save more than 11% of energy consumption in industry (compared to business as usual case) in case of the implementation of the energy efficiency and energy conservation measures in the sector where the savings can be achieved 2 million TOE by corresponding reductions in emissions of about 6 million tons of CO2 equivalent in 2030[12], (Table 16).

Table (16) estimations of energy savings and the correspondence of emissions reduction until 2030.

Expected final energy demand in industrial sector is about 6.6% Million TOE		Expected total energy save million TOE and by 11% save	Expected emission reduction of CO2 Million ton in average
2005	3.6	0.40	1.2
2010	5.0	0.55	1.6
2015	6.8	0.75	2.3
2020	9.4	1.03	3.1
2025	12.9	1.42	4.3
2030	17.8	1.96	5.9

Source (8)

Syria is a developing country with a high energy demand significantly in line with the requirements of the of rapid development, especially the industrialized ones, because the most important energy source in the industry is a fossil fuel and this fuel is important and depleted and continues to drop, so the conservation and diversification of energy sources is deemed necessary for the requirements of sustainable development and the most important of that to use of renewable energies to save and decrease the use of fossil fuel and reduce environmental pollution that results the harmful flora and fauna, particularly the mankind.[5]

The most important opportunities to achieve a big save in the consumption of petroleum derivatives are to meet the industrial sector needs of hot water by installing solar water heaters and using of solar energy technologies, where economically, for both heating water

[5] (8) - UNFCCC Mitigation Assessments

for industry or heating the compensation water in the steam production circuits, whether open or closed circuit, , or to generate electricity if it is possible and fiscal.

It is worth mentioning that, the use of solar energy applications, with the most important part of it, the solar water heater has achieved very significant savings in the reduction of energy consumption in industrial plants. where, with the increase of energy sources prices make the use of most applications of renewable energy more economical and the replacement of traditional systems in the industry by the renewable energy systems will achieve the requirements of sustainable development which can be beneficial to all.

Besides that, the energy audit studies in other countries and the national case studies have shown that, the implementation of energy conservation and energy efficiency measures is the most economical source and profitability of new energy, and it's the most environmentally friendly if it is compared with other wide energy production systems.

13. Obstacles and difficulties:

In general, there are many obstacles and difficulties for the mitigation of greenhouse gas emissions technological and economic constraints, political, cultural, social, institutional and behavior, and they can be classified into barriers related to concepts , barriers related to each sector and general barriers, and these constraints vary from time to time and from one country to another, but can be overcome through policies and programs and take advantage of opportunities.

The difficulties of reduce emissions can be identified in the industrial sector in Syria to the lack of available information , the weakness of capital investment for this purpose , lack of skills and communication , cheap energy prices , the effects of imitation and the difficulty of adapting to new technology. With regarding to the processes industrial emissions , the mitigations procedures need to additional capital investment for this purpose and necessary legislation for reducing these emissions, but regarding to the emissions of energy consumption in the industrial sector, it is less difficult and there are lots of opportunities that can be used by issuing the related legislations, laws and changing practices and behavior, culture and transfer of information ,long-term support for the selection of appropriate new technology , fiscal promotion ,funding and find a great cooperative relationship between the government and the private industrial sector , to encourage research studies on the barriers and how to overcome them and estimate the cost of removing it[8].

14. Recommendations

The study showed the reality of emissions from industry, and pointed out the most important potential opportunities to mitigate them, and to be used as a behavior or method it must take the following:

- Obliging emitting industries to make benefit of the emitting gases.
- Review technological process line for any new industry before it is adopted and study the energy balance and its emissions.
- Look for saving energy opportunities (energy conservation opportunities) and energy efficiency promotion.

- Use of renewable energy technologies, particularly solar energy techniques.
- Action is required to work on organizational and administrative techniques and the use of appropriate systems to facilitate the implementation of the recommendations.
- Create and activate a specialized office of the energy efficiency issues in each company which can take care of the development plans and programs and operational means of energy conservation and energy efficiency promotion.
- Work on the upgrading or replacement of old production line with one more efficient and less energy consumption.
- Work through plan and conduct an energy audit study each three months in each company and to propose appropriate action to improve energy efficiency.
- Use of solar energy technologies where they are economically, especially solar water heaters for industrial processes or heating the compensation water in the steam production circuits.
- Cogeneration of heat and power in the industries of cement , iron and steel, oil refining, textile , paper, glass. food
- Use of Energy Management Systems (EMS) and optimal control of energy sources in line with the operation and maintenance systems and use of control systems (sensors) for lighting, heating, ventilation and air conditioning systems.
- Decrease the heat losses through the thermal insulation which lead to save about 5 - 20% of energy consumption[8].

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