

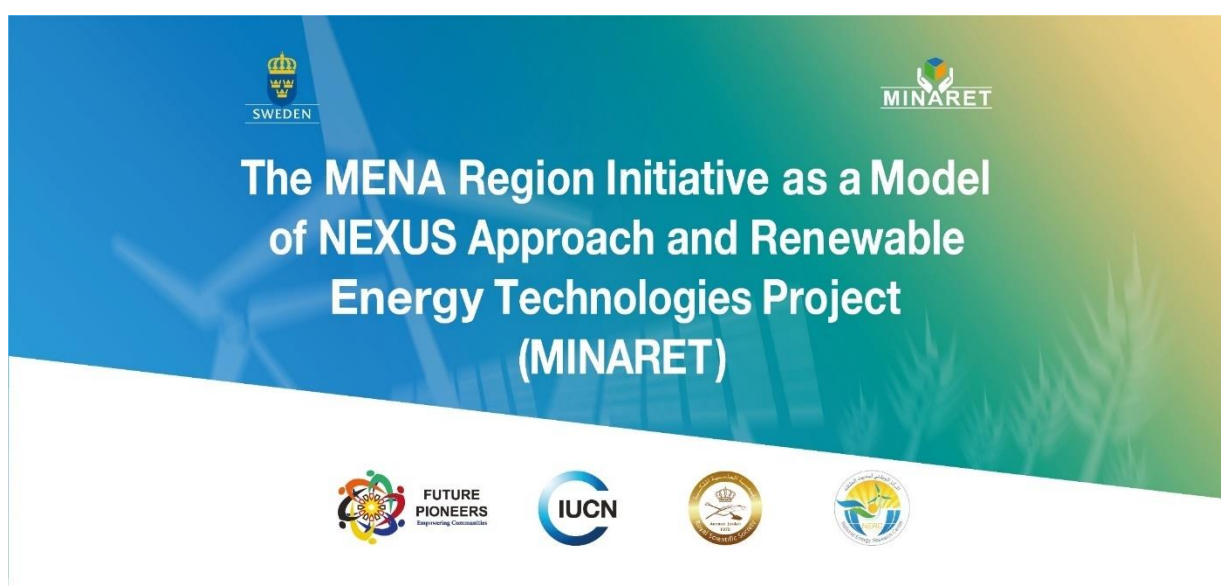
Baseline Emission Inventory (BEI)–Tunisia

Monastir Municipality

Prepared by

The Royal Scientific Society

The National Energy Research Center



July 2019

The MENA Region Initiative as a model of NEXUS Approach and Renewable Energy Technologies (MINARET)

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1. Introduction

1.1 Current status

1.1.1 Geographical location

Monastir is a city on the central coast of Tunisia, in the Sahel area. It is 20 kilometers (12 miles) south of Sousse and 162 kilometers (101 miles) south of Tunis, the capital. Traditionally a fishing port, Monastir is now a major tourist resort. Its population is about 101,934. It is the capital of Monastir Governorate. ^[1]

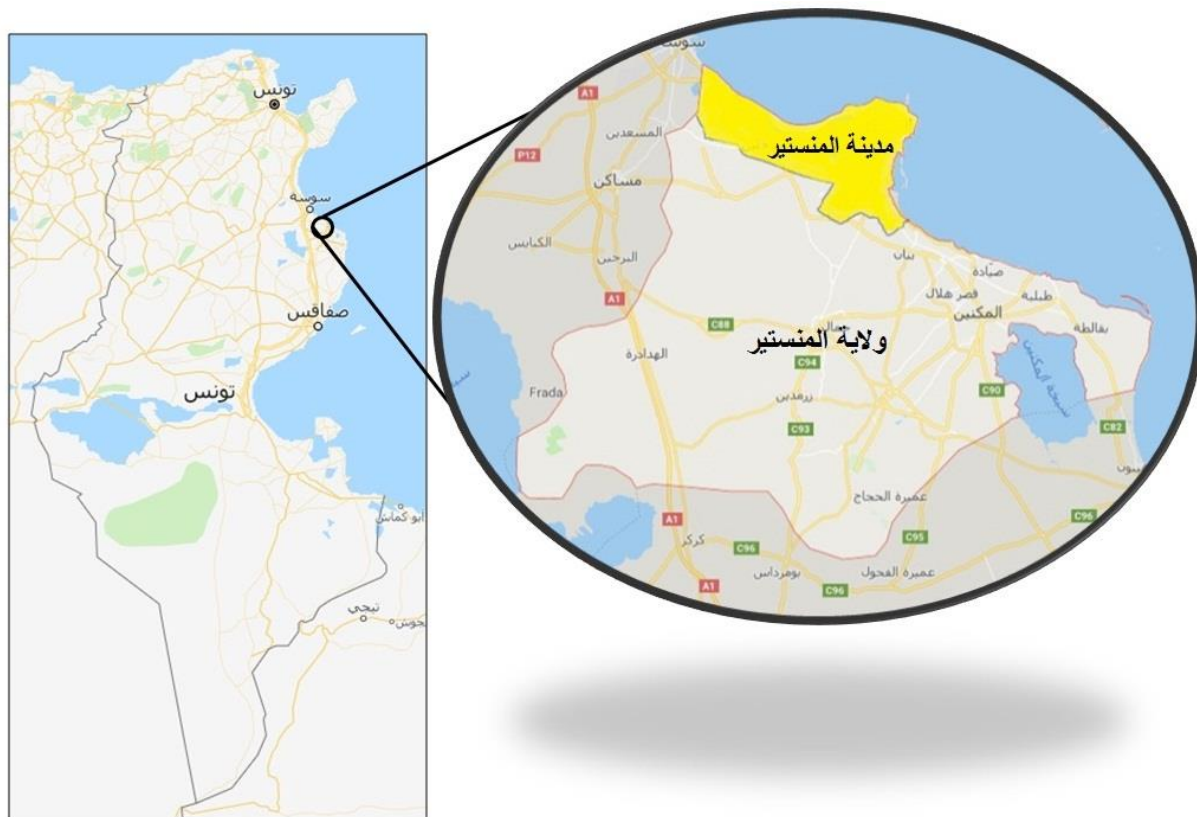


Figure 1: Monastir map

The city is known for its castle which called “Ribat of Monastir”. It is a ribat, an Islamic defensive structure, located in Monastir, Tunisia. It is the oldest ribat built by the Arab conquerors during the Muslim conquest of the Maghreb ^[2]. It is Founded in 796 by the Abbasid leader and the governor of Ifriqiya, Harthama ibn A'yan, several improvements and changes were introduced to the building throughout the medieval times, including the expansion carried out by Abu al-Qasim ibn Tammam in. It contains a maze of corridors and chambers ^[2]. A characteristic picture of the castle is presented in Figure 2.

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Figure 2 : Ribat of Monastir

1.1.2 Climate characteristics

In Monastir, the summers are hot, muggy, dry, and clear and the winters are long, cool, windy, and mostly clear. Over the course of the year, the temperature typically varies from 9°C to 32°C and is rarely below 5.5°C or above 36°C.

The hot season lasts for 2.9 months, from June 21 to September 19, with an average daily high temperature above 28°C. The hottest day of the year is August 6, with an average high of 31.6°C and low of 23.8°C. The cool season lasts for 3.9 months, from November 29 to March 27, with an average daily high temperature below 67°F. The coldest day of the year is January 19, with an average low of 8.9°C and high of 16°C.^[1]

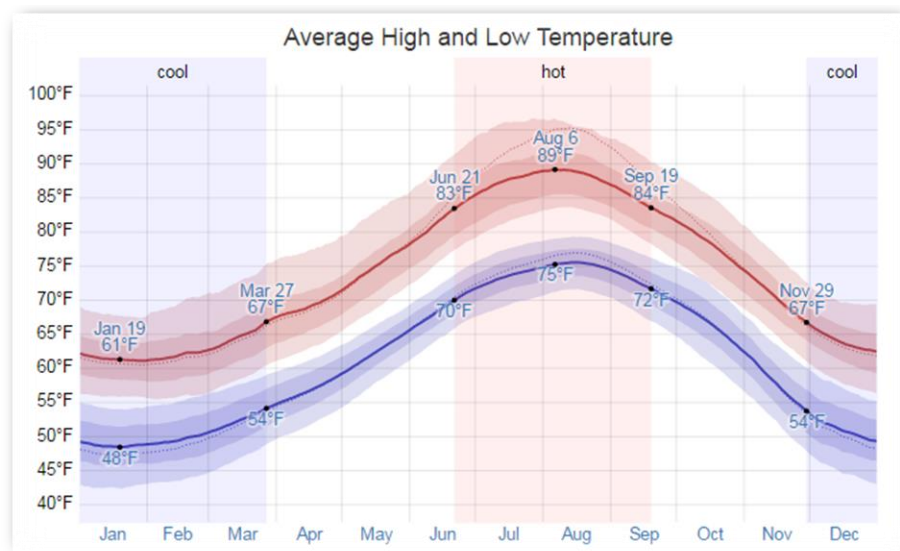


Figure 3

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The figure below shows a compact characterization of the entire year of hourly average temperatures. The horizontal axis is the day of the year, the vertical axis is the hour of the day, and the color is the average temperature for that hour and day.^[1]

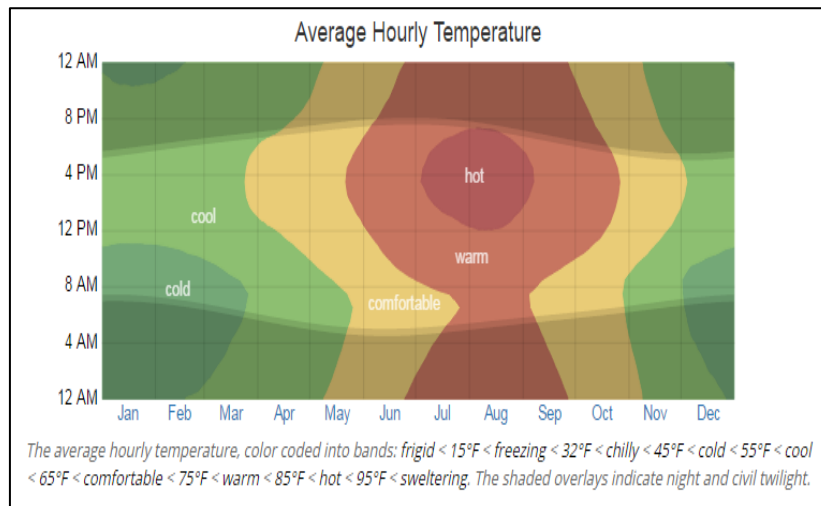


Figure 4

Clouds

In Monastir, the average percentage of the sky covered by clouds experiences significant seasonal variation over the course of the year.

The clearer part of the year in Monastir begins around June 14 and lasts for 2.9 months, ending around September 12. On July 27, the clearest day of the year, the sky is clear, mostly clear, or partly cloudy 97% of the time, and overcast or mostly cloudy 3% of the time. The cloudier part of the year begins around September 12 and lasts for 9.1 months, ending around June 14. On October 26, the cloudiest day of the year, the sky is overcast or mostly cloudy 39% of the time, and clear, mostly clear, or partly cloudy 61% of the time.^[1]

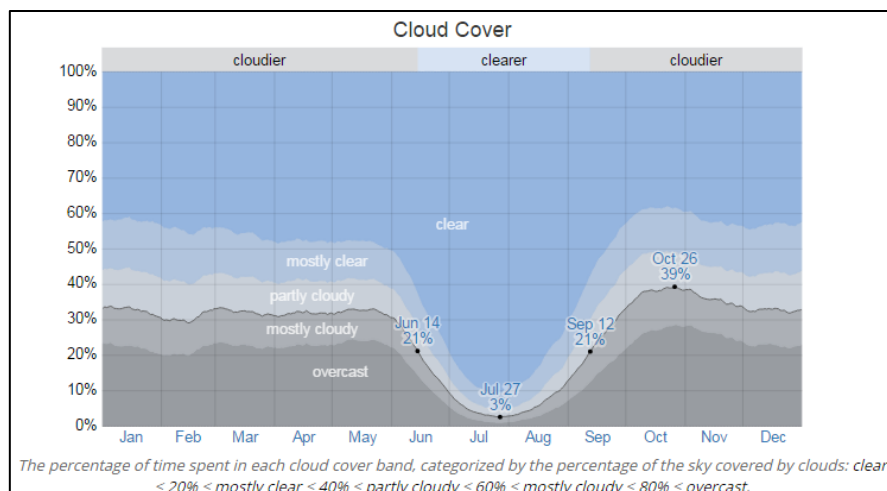


Figure 5

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Precipitation

A wet day is one with at least 0.04 inches of liquid or liquid-equivalent precipitation. The chance of wet days in Monastir varies throughout the year.

The wetter season lasts 8.5 months, from August 30 to May 15, with a greater than 10% chance of a given day being a wet day. The chance of a wet day peaks at 18% on October 9. The drier season lasts 3.5 months, from May 15 to August 30. The smallest chance of a wet day is 2% on July 5.

Among wet days, it can be distinguished between those that experience rain alone, snow alone, or a mixture of the two. Based on this categorization, the most common form of precipitation throughout the year is rain alone, with a peak probability of 18% on October 9.^[1]

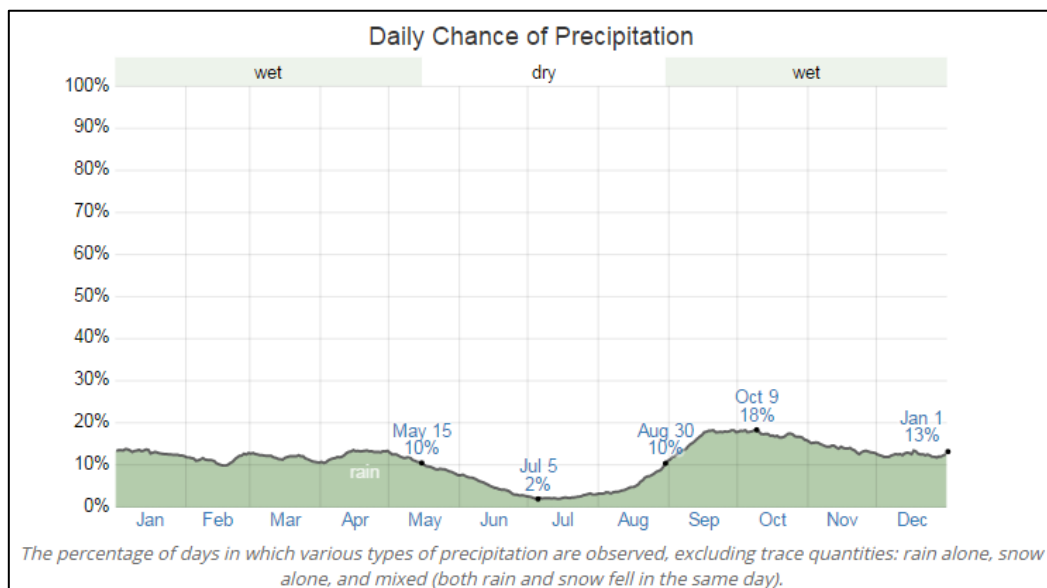


Figure 6

Rainfall

To show variation within the months and not just the monthly totals, the rainfall accumulated over a sliding 31-day period centered around each day of the year. Monastir experiences some seasonal variation in monthly rainfall.

The rainy period of the year lasts for 9.2 months, from August 23 to May 30, with a sliding 31-day rainfall of at least 0.5 inches. The most rain falls during the 31 days centered around October 1, with an average total accumulation of 1.5 inches. The rainless period of the year lasts for 2.8 months, from May 30 to August 23. The least rain falls around July 10, with an average total accumulation of 0.1 inches.^[1]

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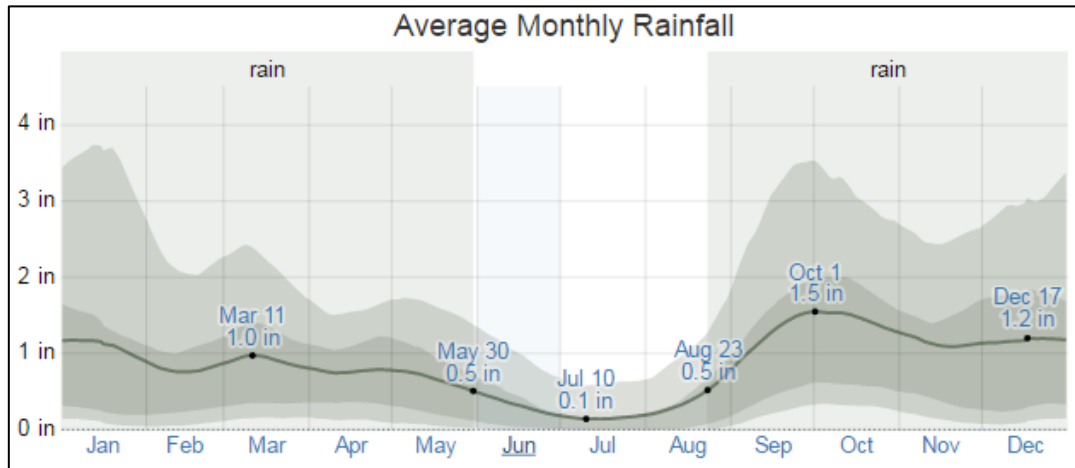


Figure 7

Humidity

We base the humidity comfort level on the dew point, as it determines whether perspiration will evaporate from the skin, thereby cooling the body.

Lower dew points feel drier and higher dew points feel more humid. Unlike temperature, which typically varies significantly between night and day, dew point tends to change more slowly, so while the temperature may drop at night, a muggy day is typically followed by a muggy night.

Monastir experiences extreme seasonal variation in the perceived humidity. The muggier period of the year lasts for 4.9 months, from June 1 to October 28, during which time the comfort level is muggy, oppressive, or miserable at least 22% of the time. The muggiest day of the year is August 17, with muggy conditions 85% of the time. The least muggy day of the year is February 4, when muggy conditions are essentially unheard of. ^[1]

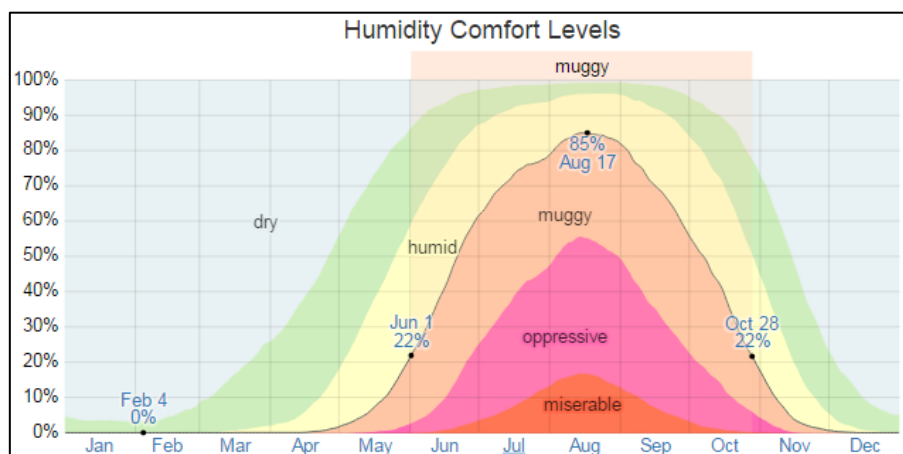


Figure 8

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Wind

This section discusses the wide-area hourly average wind vector (speed and direction) at 10 meters above the ground. The wind experienced at any given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages.

The average hourly wind speed in Monastir experiences mild seasonal variation over the course of the year. The windier part of the year lasts for 6.0 months, from November 3 to May 2, with average wind speeds of more than 5.8 miles per hour. The windiest day of the year is December 19, with an average hourly wind speed of 6.8 miles per hour. The calmer time of year lasts for 6.0 months, from May 2 to November 3. The calmest day of the year is August 12, with an average hourly wind speed of 4.8 miles per hour. ^[1]

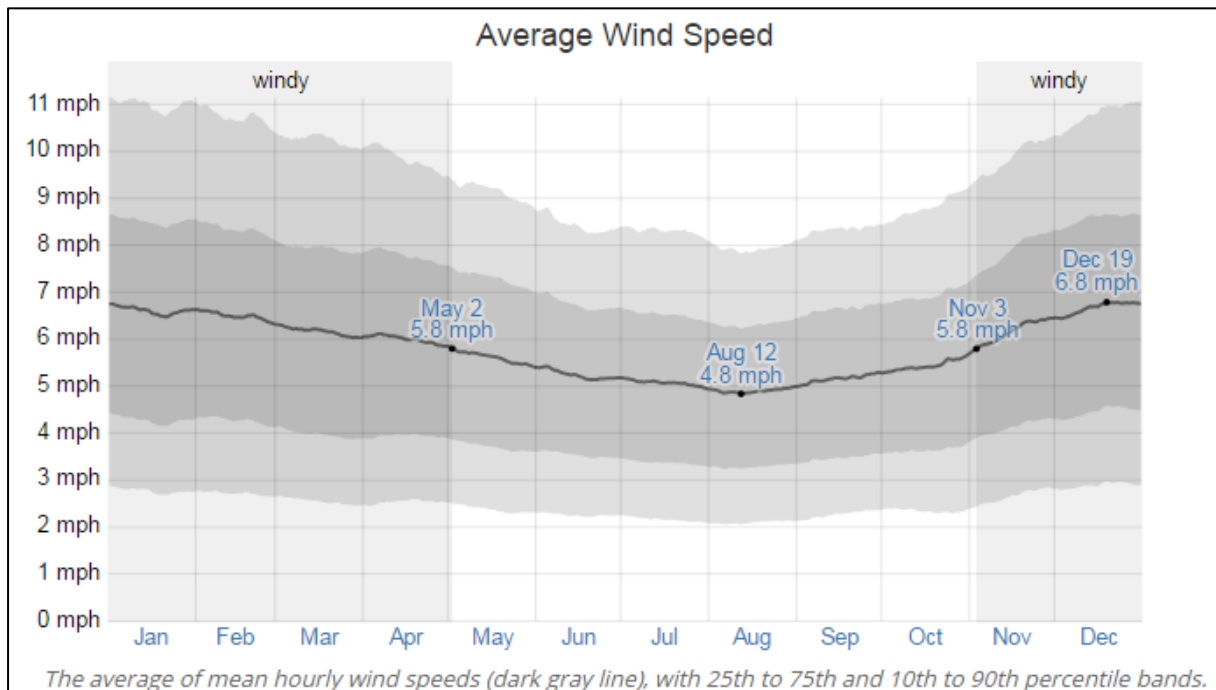


Figure 9

The predominant average hourly wind direction in Monastir varies throughout the year. The wind is most often from the north for 9.4 months, from February 6 to November 18, with a peak percentage of 43% on July 22. The wind is most often from the west for 2.6 months, from November 18 to February 6, with a peak percentage of 38% on January 1. ^[1]

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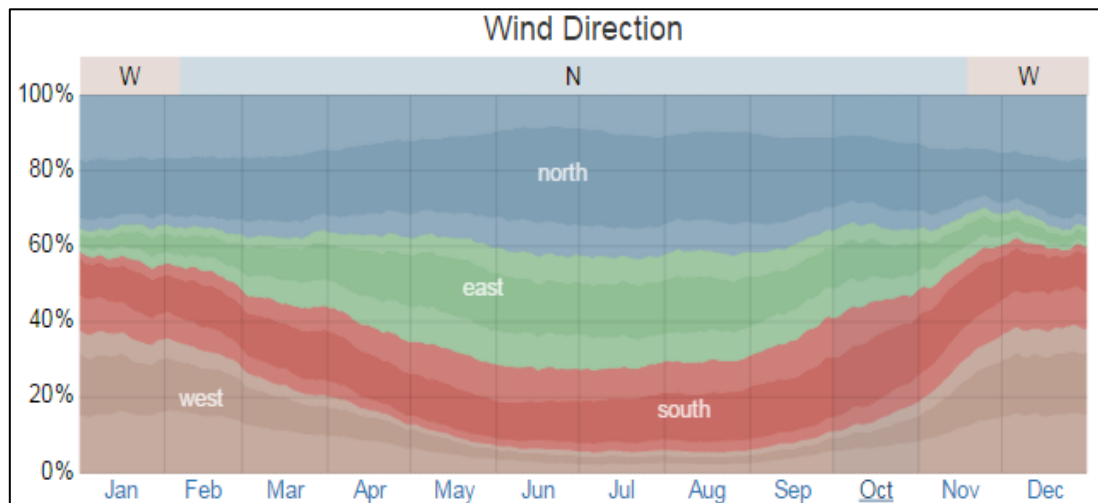


Figure 10

Water Temperature

Monastir is located near a large body of water (e.g., ocean, sea, or large lake). This section reports on the wide-area average surface temperature of that water.

The average water temperature experiences significant seasonal variation over the course of the year. The time of year with warmer water lasts for 3.1 months, from July 7 to October 11, with an average temperature above 24°C. The day of the year with the warmest water is August 20, with an average temperature of 26.6°C. The time of year with cooler water lasts for 4.1 months, from December 26 to April 30, with an average temperature below 17.2°C. The day of the year with the coolest water is February 26, with an average temperature of 14.5°C. ^[1]

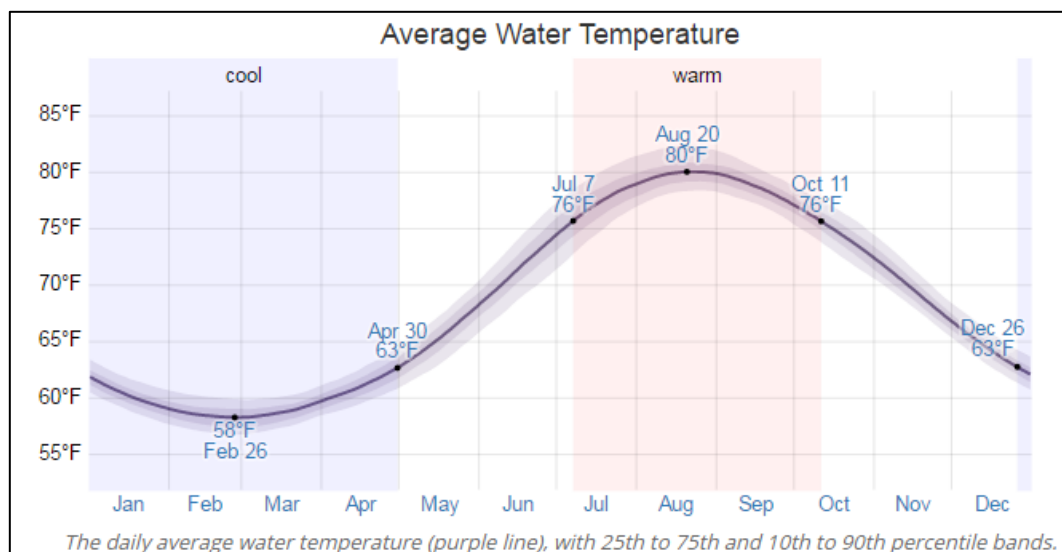


Figure 11

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Solar Energy

This section discusses the total daily incident shortwave solar energy reaching the surface of the ground over a wide area, taking full account of seasonal variations in the length of the day, the elevation of the Sun above the horizon, and absorption by clouds and other atmospheric constituents. Shortwave radiation includes visible light and ultraviolet radiation.

The average daily incident shortwave solar energy experiences extreme seasonal variation over the course of the year. The brighter period of the year lasts for 3.5 months, from May 3 to August 20, with an average daily incident shortwave energy per square meter above 6.9 kWh. The brightest day of the year is July 7, with an average of 8.0 kWh.

The darker period of the year lasts for 3.4 months, from October 28 to February 10, with an average daily incident shortwave energy per square meter below 3.7 kWh. The darkest day of the year is December 18, with an average of 2.6 kWh.^[1]

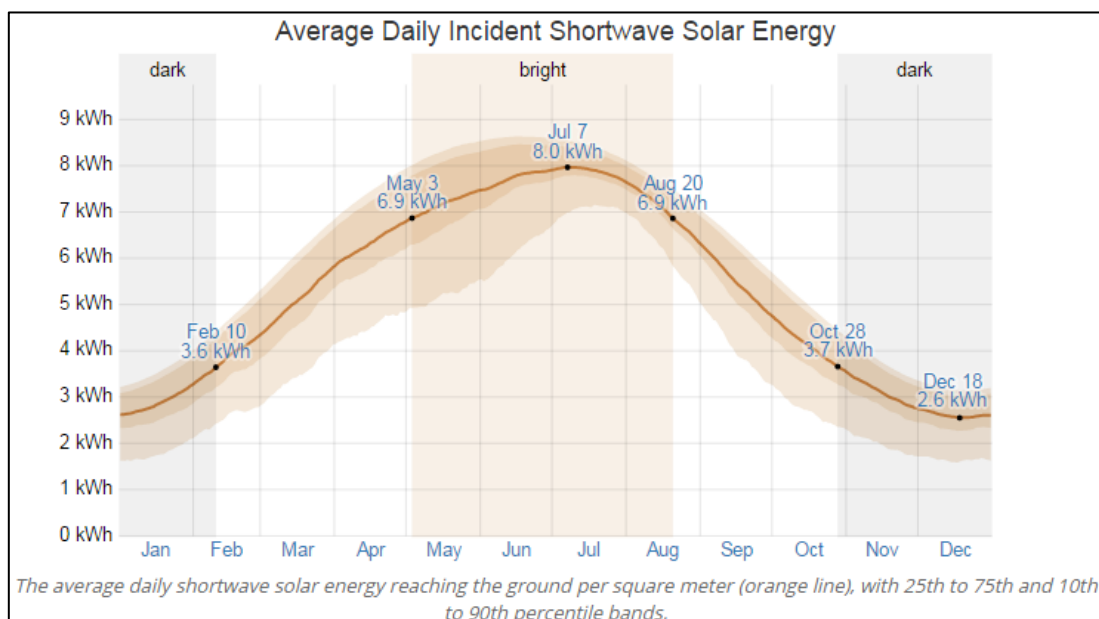


Figure 12

1.1.3 Demographic tendencies

According to the last population census of 2017, the population living in Monastir governorate has 585,283 inhabitants. Whereas the population for Monastir municipality in 2017 was 101,934 citizens.^[3]

1.1.4 Employment

Based on the statistics that was done in 2018, The employees in Monastir District comprise approximately 48.9% of its population, 4.7% of them work in agricultural sector, while 37% of them work in technical field, and 44.8% work in services. In the part of economically

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active citizens there is a 6.1% percentage that is currently unemployed and looking for a job.
[3]

1.1.5 Education

Regarding the educational status of Monastir citizens. Monastir is a prominent educational center in Tunisia, a percentage of 17.1% of the total population was enrolled in the education in 2017. The number of first primary schools has reached 20 schools in the latest statistics in 2017, where the number of second primary and secondary schools and study rooms reached 13 schools and 403 general and specialized study rooms. Total number of teachers and students in the first primary schools reached 516 teachers and 9247 students, with 17.92 average number of students per teacher.^[3]

As for higher education where there is The University of Monastir which includes 16 university institutions. The total number of students of the University of Monastir is 18,876 students with 969 administrative staff for the academic year 2017/2018, where 31.5% of them are males and 68.5% are female. The largest colleges are the Faculty of Science, followed by the Faculty of Economic Sciences and Management and the Higher Institute of Biotechnology.^[4]

1.1.6 Infrastructures

The Governorate provides a public network for access in water and drinking water. 100% of the housing units have access in the water network. In addition, it seems that there isn't a fully developed public sewage system and thus there is 85% of the population has access in the public network. The rest of the housing units are been served by cesspools. (2017) ^[2]

The road network in Monastir Municipality consists of 45 Km of paved and unpaved roads, of which 49.3% are regional roads, 19.3% local roads, and a final 31.4% farm tracks.^[3]

1.1.7 Economy

The economy of Monastir depends mainly on tourism, sea fishing and industry. Monastir industrial zone includes 51 factories, 34 of them are textile factories with total number of employees reached 4,767 in 2017.

Also Monastir is characterized by Sea fishing, where Number of fishing boats are 261 with total Sea fishing production of 3,241 tons per year. Whereas the total number of manpower in sea fishing is around 900 in 2017.^[3]

As for tourism in Monastir, it contains many monuments, archaeological sites and museums, in addition to Monastir beaches, where the total number of hotels and hostels are 89, where 46% of them are classified hotels with total Housing Capacity of 24,264 guests.^[3]

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2. Baseline Emission Inventory (BEI)

2.1 BEI Methodology

2.1.1 Baseline Year

According to the Covenant of Mayors Guidelines for South Signatories, in order to develop the energy balance sheet and consequently specify the CO₂ emissions, the year 1990 should be considered as the baseline year. In case where there aren't adequate data for this year, as a baseline year should be considered the nearest year to 1990 for which there are complete and reliable data. Thus, for the Monastir Municipality the baseline year has been set to 2016, since it was the year with the most sufficient and reliable data available. ^[5]

2.1.2 BEI administrative boundaries

Following a meeting of the consultant National energy Research Center (NERC) with the Monastir representatives, it was made clear that their wish for the BEI is to cover the administrative boundaries of Monastir municipality.

2.1.3 Sectors to be included in the BEI

The sectors for which the appropriate data were gathered and calculations for the total energy consumption and CO₂ emissions are presented below:

A. Buildings, Equipment & Facilities

- Municipal Buildings, Equipment and Facilities
- Public lighting
- Residential buildings
- Tertiary buildings, equipment and facilities (non municipal)
- Water and Waste water facilities.
- Industrial Sector

B. Transport

- Municipal fleet
- Urbain Rail transport
- Urbain Public transport
- Urbain Private and Commercial transport
- Local Ferries transport

C. Solid waste management.

D. Livestock breeding.

As regards agriculture, although there is agricultural activity in the region, it has not been possible to separate the consumptions for the specific sector from the tertiary one, and especially the water pumping for irrigation.

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2.1.4 Emission factors and Conversion rates

The emission factors which are used in this BEI were derived from the Covenant of Mayors Guidebook in table 1. With the only exception of the electricity emission factor which is characteristic for the country. The emission factor was calculated based on the Tunisian energy mix and the electricity consumption. According to the National Agency for Energy Conservation “Agence Nationale pour la Maîtrise de l’Énergie” (ANME), the electricity emission factor in Tunisia is 0.602 tnCO_{2equivalent}/MWh.

Table 1: Emission Factors & Conversion Rates

	Emission Factor (tn CO ₂ /MWh)	Conversion Factors	Source
Electricity	0.602	Not applicable	ANME
Natural Gas	0,202	11,6 MWh/tn	CoM / IPCC
Diesel	0,267	10 KWh/lt	CoM / IPCC
Gasoline	0.249	9,2 KWh/lt	CoM / IPCC
Solar (thermal/ PV)	0	Not applicable	

Furthermore, emissions from the biomass were calculated according to the IPCC method. Waste separation process, Sewage Sludge and livestock breeding create methane emissions (CH₄) which are converted to CO₂ emissions according to the equivalence “1 tn CH₄ = 25 tn CO₂”.

2.2 Energy Consumption

The total amount of energy consumed in Monastir Municipality is 577,867 MWh. The allocation of this energy consumption among the different sectors, by fuel type, is presented in the next table. Further analysis of the consumptions per sector is provided in the following sections.

Table 2: Total Energy consumption per sector

MWh/ Sector	Electricity	Natural Gas	Diesel	Gasoline	Solar Thermal	Total
Residential sector	54,080	35,936			4,856	94,872
Municipal Buildings	898	19				917
Tertiary Sector	79,792	46,707	1,186			127,685
Industrial Sector	22,360	93,257				115,617
Public street lighting	5,378					5,378
Transportation Sector	2,630		69,819	160,949		233,398
Total	165,137	175,919	71,005	160,949	4,856	577,867

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2.2.1 Municipal Buildings & Facilities

Tunisian Electricity & Gas Company provided electricity and NG consumptions for the year 2016 for municipal buildings, organized by building category: Administration, Markets and Slaughterhouses, Culture, Gardens, Sport. The total electricity and NG consumption of buildings and facilities in the municipality amounts to **917 MWh** (excluding municipal lighting). (See Appendix A).

2.2.2 Municipal public lighting

As far as the municipal public lighting is concerned, this sector is related to the street lighting and public areas' lighting. The electricity consumption for this sector is **5,377.6 MWh** according to prepared study by the municipality in 2016. (See Appendix B).

2.2.3 Residential Buildings

Electricity

Monastir's households consume electricity for lighting and electrical appliances such as refrigerator, air conditions and others, as well as in water heating. The consumed electricity in this sector is **54,080 MWh** in 2016 according to statistics prepared by Ministry of Development, Investment and International Cooperation (MDIIC) ^[3].

Natural Gas (NG)

The only source for space heating and cooking in the houses is the natural gas fuel. Estimations for NG consumption (Low pressure) were realized according to the data given from STEG and statistics by MDIIC. The percentage of share for residential sector was considered as same as for electricity with share percentage of 36.92% of overall NG consumption (except for agricultural, water pumping and waster sector since they do not depend on the population). The annual NG consumption in Monastir district was given for 2016 by the municipality with total value of (23 ktoe) for 33 municipalities within Monastir district. The percentage of consumption for Monastir delegation was calculated by knowing the total subscribers number for each involved municipality as shown in the table below ^[3]. Based on that, the annual NG consumption in Monastir Delegation for all sectors was calculated to be 9.5 ktoe. Since Monastir delegation has two municipalities (Monastir and Khaniss Municipalities), the NG consumption was projected based on the population ratio between the two municipalities, which is 88.25% for Munastir municipality with overall NG consumption of 8.38 ktoe. After excluding Agriculture, water pumping and waste water sectors from the overall natural gas consumption, the remaining overall NG consumption is 8.369 ktoe. Finally, by using the calculated share percentage of residential sector, the annual NG consumption for residential sector can be calculated to be 3.09 ktoe (35,936 MWh) for Monastir municipality.

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Table3: Annual NG (Low pressure) consumption for Munastor district 2016

Delegations within Monastir district	Number of Subscribers	Percentage of subscription	Annual NG Consumption (ktoe)
Monastir	22575	41.31%	9.50
Wardanin	3	0.01%	0.00
Sahlin	2976	5.45%	1.25
Zarmadin	874	1.60%	0.37
Bani Hassan	6	0.01%	0.00
Jammal	4267	7.81%	1.80
Banbalah	3354	6.14%	1.41
Maknin	4868	8.91%	2.05
Baqaltah	1179	2.16%	0.50
Tablabah	1984	3.63%	0.84
Qasr Hilal	7388	13.52%	3.11
Qasibat Almadyony	1277	2.34%	0.54
Sayyadah-lamtah-bo hajar	3894	7.13%	1.64
Total	54645	100.00%	23

Solar thermal

In addition, a great number of households own solar water heaters, thus they consume solar power in order to heat water. In order to determine this quantity, IEA gave data at a national level (558,240 MWh) ^[8], and subsequently the solar thermal energy was calculated by knowing the population ratio between municipal and national levels. The total population at national level was 11,229,700 in 2016, whereas the population at municipal level was 98,084 (according statistics by MDIIC ^[3]) with population ratio of 0.87%. Based on that, the annual solar thermal consumption at the municipal level is calculated to be 4,856 MWh.

Summary

Gathering all the data of the residential sector, it seems that residents consume 3 distinct energy sources. In table and figure below, the final consumption per fuel type for this sector is presented.

Table 4 : Total energy consumption in the residential sector

MWh/year	Residential Sector
Electricity (MWh)	54,080
Natural Gas (MWh)	35,936
Solar Thermal (MWh)	4,856
Total (MWh)	94,872

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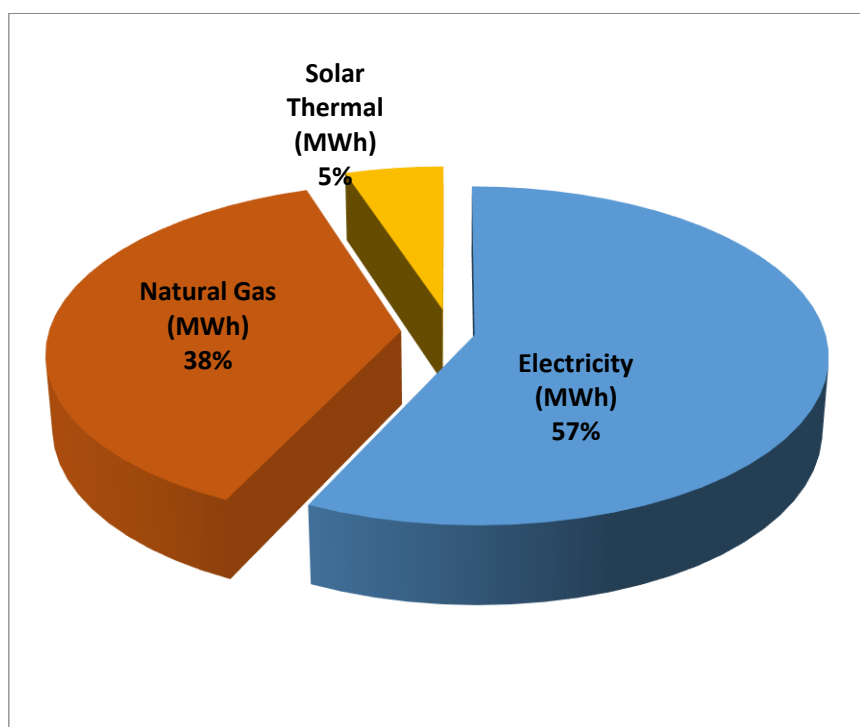


Figure 13: Energy consumption per fuel in Residential Sector

2.2.4 Tertiary Buildings, Equipment & Facilities

Tertiary sector includes all buildings that not referred to the municipal and industrial sectors, which includes the commercial buildings such as shops, restaurants, hotels, offices, hospitals. Also this sector includes the educational buildings (Schools and Universities), public buildings and water management facilities as well, which provide services to Monastir's citizens. It should be noted that water management facilities include facilities for water pumping and waste water treatment. In case of commercial buildings, the approach used to calculate the annual NG consumption is same one used for residential sector. Based on that, the annual NG consumption at municipal level is calculated to be (46,707 MWh). The annual electricity consumption was given by MDIIC statistics and bills with total value of (79,792 MWh). The collected data are presented in the table below.

Table 5: Energy consumption in tertiary sector per type of sub-sector

Types of Buildings in the Tertiary Sector	Electricity (MWh)	Natural Gas (MWh)	Diesel (MWh)	Total (MWh)
Commercial buildings	17,678	11,747	0	29,425
Public & Governmental buildings	18,686	12,417	0	31,103
Tourism	33,670	22,374	0	56,044
Agricultural	1,455	68	1,186	2,709
Water & Waste Management Facilities	8,302	102	0	8,404
Total	79,792	46,707	1,186	127,685

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In the next charts, it is obvious that the consumption's allocation in the tertiary sector is dominated by Tourism and commercial & public buildings.

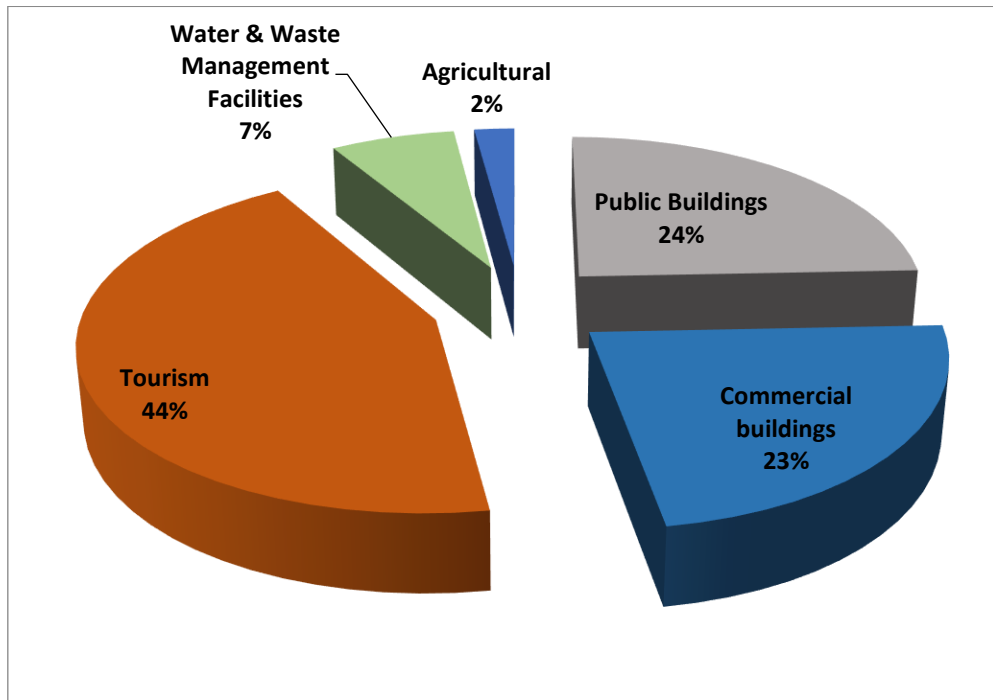


Figure 14: Energy consumption in tertiary sector per type of building

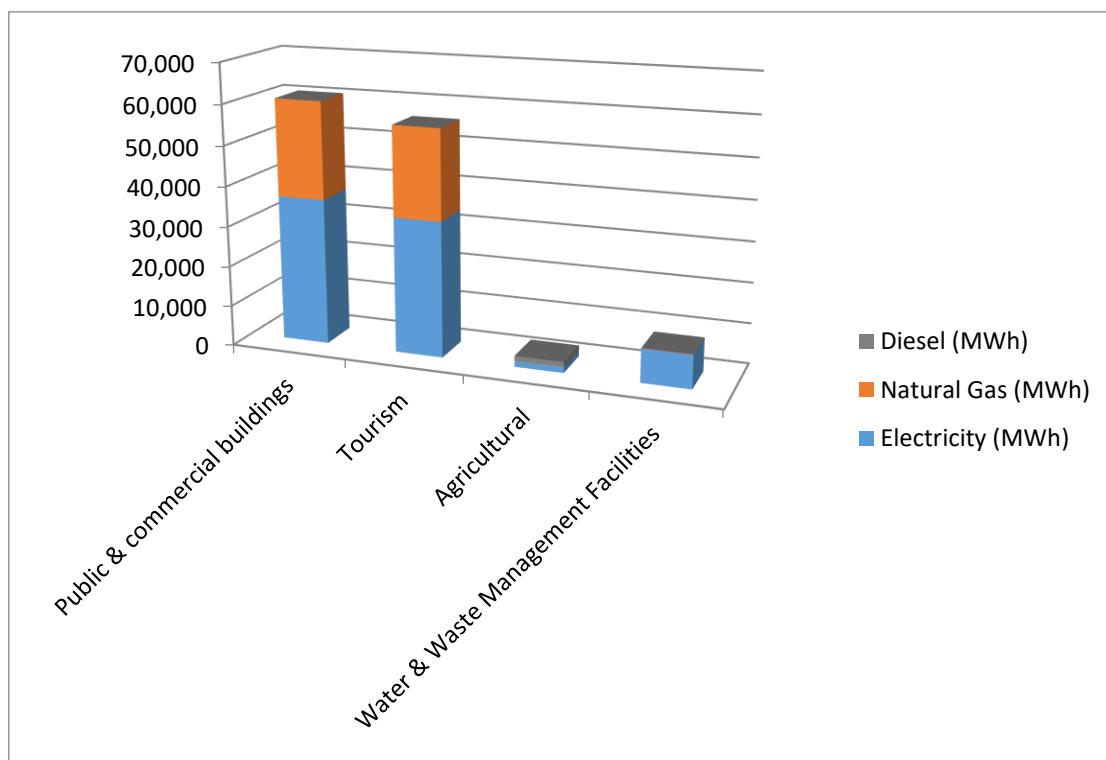


Figure 15: Energy consumption in tertiary sector per type of building and fuel

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2.2.5 Buildings' & facilities Synopsis

The consumed energy allocation for all the buildings and facilities in Monastir Municipality is presented in the next figure.

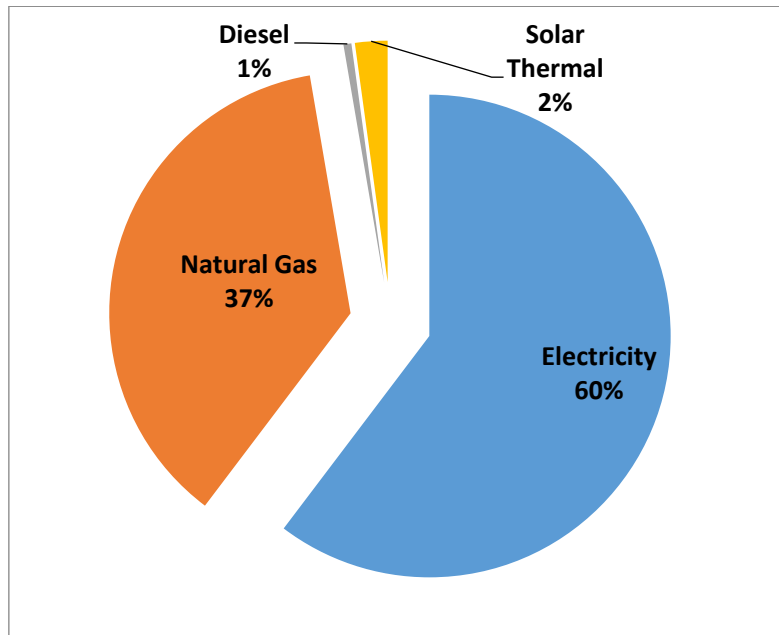


Figure 16: Energy consumption in buildings and facilities per fuel

2.2.6 Industrial Sector

Electricity consumption for industrial sector was given according to MDIIC statistics with total amount of (22,360 MWh/yr) ^[3].

Natural gas consumption was calculated using the data from STEG and statistics, which the same approach done for the previous sectors was adopted for the industrial sector. The percentage of consumption for Monastir municipality was calculated by knowing the total NG (Medium pressure) consumption for each involved municipality in Monastir for 2015 year (as provided by MDIIC statistics ^[3]), which can be reflected on the provided annual NG (Medium pressure) for 2016 (110.5 ktoe) as shown in the table below, which the annual NG (MP) consumption is 78,399 MWh after taking the pop ratio for Munastir delegation in consideration.

Table 6: Annual NG (Medium pressure) consumption for Monastir district 2015/2016

Delegations within Monastir district	NG (MP) consumption (MThermie) 2015	Weight (%)	NG (MP) Consumption (Ktoe) (2016)
Monastir	146	6.91%	7.64
Wardanin	0	0.00%	0.00
Sahlin	37	1.75%	1.94
Zarmadin	820	38.83%	42.90

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bani hassan	0	0.00%	0.00
Jamal	523	24.76%	27.36
Banbalah	264	12.50%	13.81
Maknin	63	2.98%	3.30
Baqaltah	3	0.14%	0.16
Tablabah	107	5.07%	5.60
Qasr hilal	92	4.36%	4.81
Qasibat almadyny	0	0.00%	0.00
Sayyadah-lamtah-bo hajar	57	2.70%	2.98
Total	2,112	100.00%	110.5

On the other hand the Low pressure NG consumption can be simply computed by subtract the Annual NG consumption by residential and tertiary sectors from the total annual NG (Low pressure) consumption. Thus, the total NG consumption (LP & MP) was calculated to be 93,257 MWh/yr

2.2.7 Transport Sector

2.2.7.1 Urban Rail Transportation

One of the most important transportation ways in Monastir is by the rail transport, where there are 22 Electric trains and other Gasoil trains serve the travelers which controlled by the National Railway Company of Tunisia (NRCT).

The annual electrical energy consumption for this sector can be calculated by knowing the annual traveled distance (km) within Monastir boundaries and the specific energy consumption per distance (kWh/km). based on data received from (NRCT), the annual travelled distance by the rail transport along the line (end to end) for 2016 is **998,063 km** with total traveled strokes of (**14,607 strokes**), Knowing that one complete stroke (end to end) has a distance of **68.3 km**, whereas the length of the rail line crossing Monastir borders is **16.8 km** (according to NRCT responsible). Also the specific electricity consumption (kWh/km) for the line was given by NRCT for each month with the traveled distance. Thus, by considering all the above numbers, the estimated annual energy consumption in the rail transport within Monastir borders is **2,630 MWh**. Further analysis is presented in Table 7.

Also there are some Gasoil trains which consume 330,931 Liters per year (according to NRCT responsible). Which fuel consumption within Monastir municipality borders can be estimated using the same above approach to be 81,367 Liters per year (813.6 MWh/yr).

Table 7: Energy Consumption in Rail transportation within Monastir Municipality borders 2016

2016	Total traveled distance (end to end)(km)	Total Traveled distance within Monastir Borders (km)	Specific electricity consumption (kWh/km)	Energy consumed within Monastir Municipality borders (kWh)
Jan	84,574	20,795	9.47	196,924

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Feb	82,565	20,301	11.14	226,148
Mar	87,888	21,609	10.37	224,089
Apr	84,172	20,696	10.26	212,338
May	87,512	21,517	10.9	234,534
Jun	66,400	16,326	11.38	185,790
Jul	75,856	18,651	10.8	201,431
Aug	78,368	19,269	12.08	232,765
Sep	85,033	20,907	11.26	235,417
Oct	89,747	22,066	10.4	229,491
Nov	87,888	21,609	10.25	221,496
Dec	88,060	21,652	10.59	229,291
Total	998,063	245,398	Avg. = 10.74	2,629,715

2.2.7.2 Municipal fleet

As far as the consumption of the municipal vehicles is concerned, the available data, followed by the vehicles' type, was collected and is presented in the next table. Monastir's municipal fleet has 71 vehicles which use diesel and gasoline.

Table 8: Annual Energy Consumption in Municipal fleet of Monastir

Type of Municipal vehicles	Number of vehicles	Diesel		Gasoline		Total
		Lit	(MWh)	Lit	(MWh)	(MWh)
Waste transportation Vehicles and heavy vehicles	33	181,532	1,815	5,160	47	1,863
Passengers Vehicles	38	16,851	169	52,460	483	651
Total	71	198,383	1,984	57,620	530	2,514

2.2.7. 3 Urban Road Public Transport

Urban Public transport refers to buses and taxis that serve Monastir's citizens. The data for fuel consumption are available for buses only, whereas the taxis and Louage taxis consumptions were calculated based on the data given for the total taxis number and daily fuel consumption within Monastir municipality limits. The energy consumption results are summarized in table 9 (see appendix C).

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Table 9: Energy consumption in Public Transport within Monastir municipality borders

Vehicle Type	Number of vehicles passing the Monastir municipality borders	Daily Fuel consumption per vehicle (Lit/day)	Diesel (MWh)	Gasoline (MWh)	Total (MWh)
Buses			8,740	0	39,631
Taxis	600	12	0	25,544	
Louage (within the district borders)	28	25	2,555	0	
Louage (outside the district borders)	51	15	2,792	0	
Total			14,087	25,544	

2.2.7.4 Urban Road Private and Commercial Transport

The previous methodological approach and assumptions was used in this sector too. In Appendix C is presented the detailed analysis per vehicle category. The total number of registered private and commercial vehicles for 2016 year was not available, thus, a published statistic study was used to estimate the vehicles types and numbers in Tunisia ^[10]. Then the total number for each vehicle category was reflected to municipal level based on the population ratio and the activity ratio in the municipality. The total estimated vehicles number in Monastir municipality is 17,365 and the total consumption regarding Diesel and Gasoline is 187,619 MWh. Table 10 shows the analysis results and outputs regarding the diesel and gasoline consumptions.

Table 10: Energy consumption in Private and Commercial Transport

Vehicle Type	Number of vehicles	Diesel (MWh)	Gasoline (MWh)	Total (MWh)
Passengers Vehicles	13,642	122	134,875	187,619
Commercial Vehicles	3,589	51,029	0	
Heavy and construction Vehicles	114	1,572	0	
Agricultural Vehicles	20	21	0	
Total	17,365	52,744	134,875	

Figure 16 presents the proportion between Diesel and Gasoline consumption in the Private and Commercial vehicles.

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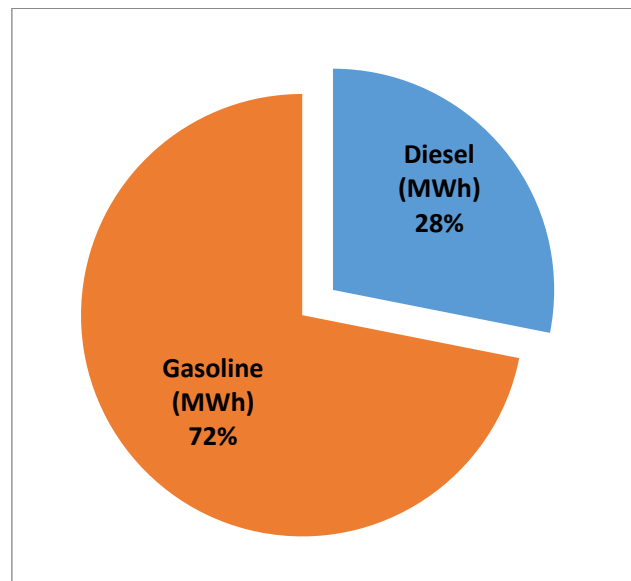


Figure 17: Energy consumption in Private and Commercial vehicles per fuel

2.2.7.5 Local Ferries Transport

Due to existing of Marina Monastir within Monastir Municipality borders, the energy consumption for Local Ferries will be considered. The fuel consumption for the local ferries was calculated based on the data given for the total ferries number and daily fuel consumption within Monastir municipality limits as well as the number of days per year that have ferries travels. The energy consumption results are summarized in table 11.

Table 11: Energy consumption in Local Ferries Transport

No.	Name of ferry	Passengers Capacity	No of days that have ferries travels (Days/yr)	fuel cons. Per day as per municipality data	Annual fuel consumption for one ferry (Lit/yr)	MWh/yr
1	Barbaros	120	30	80.0	2,400	24
2	AlBasha	76	50	40.0	2,000	20
3	Lac majeur 2	56	60	80.0	4,800	48
4	Hanba'l	72	50	40.0	2,000	20
5	AlQursan	75	60	60.0	3,600	36
6	Sultan	90	50	80.0	4,000	40
Total					18,800	188

Table 12 and figure 18 summarize the overall energy consumption and share for each transportation sector, which show that the overall energy consumption is 319,184 MWh/yr, whereas urban road private transportation take the largest share with percentage of 35%.

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Table 12 : Total energy consumption for transportation sector within Monastir municipality borders

Vehicle Type	Number of vehicles	Electricity (MWh/yr)	Diesel (MWh/yr)	Gasoline (MWh/yr)	Total MWh
Municipal Fleets	71	0	1,984	530	2,514
Urban rail transport	> 22	2,630	814	0	3,443
Urban Public Transport	> 600	0	14,087	25,544	39,631
Urban Private and Commercial Transport	17,365	0	52,744	134,875	187,619
Local Ferries Transport	6	0	188	0	188
Total		2,630	69,817	160,949	233,396

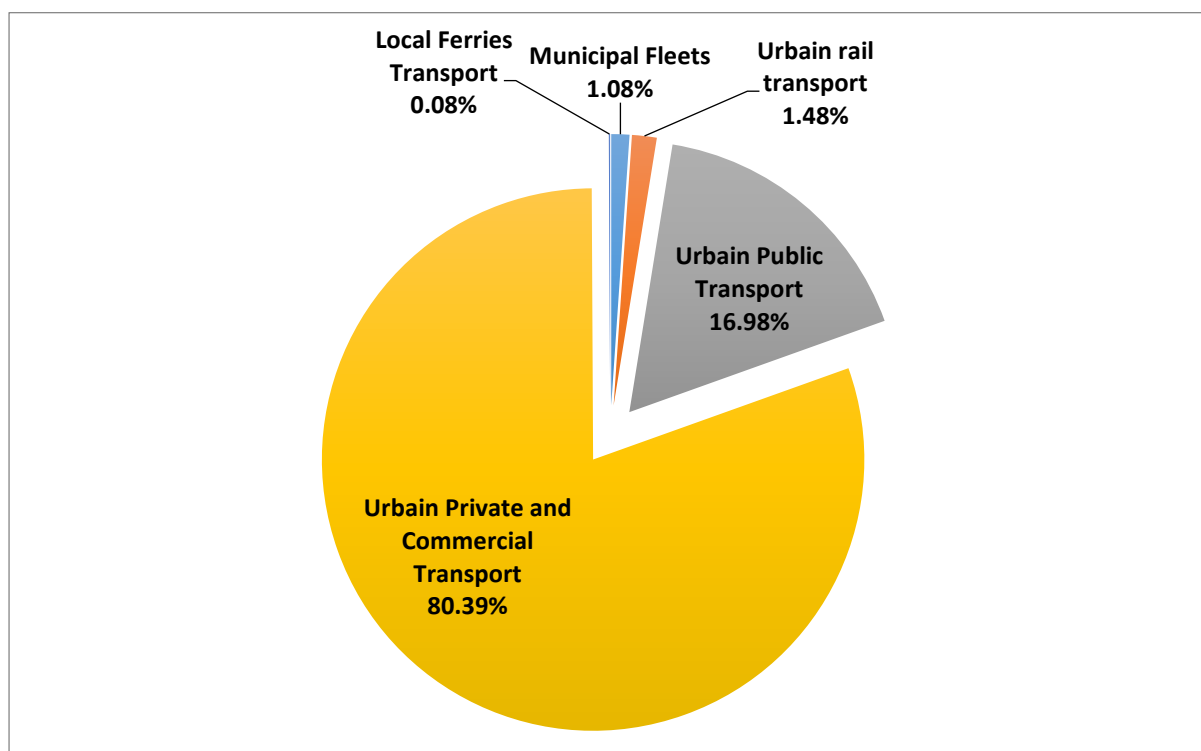


Figure 18: Energy consumption distribution in transportation sector

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2.2.8 Final Energy Consumption

In the next table all the energy consumptions within Monastir municipality are presented, with total energy consumption of 577.8 GWh.

Table 13: Total Energy Consumption in Monastir municipality

Sector			FINAL ENERGY CONSUMPTION [MWh]							
			Electricity	Heat/cold	Fossil fuels				Renewable energies	Total
					Natural Gas (Low Pressure)	Natural Gas (Medium Pressure)	Diesel	Gasoline	Solar Thermal	
Residential sector			54,080		35,936				4,856	94,872
Municipal Buildings			898		19					917
Tertiary Sector			79,792		46,707		1,185.84			127,685
Industrial Sector			22,360		14,858	78,399				115,617
Public street lighting			5,378							5,378
Transportation Sector	Urban Road Transportation	Municipal Fleets					1,983.83	530		2,514
		Public Transportation					14,087.25	25,544		39,631
		Private Transportation					52,744.17	134,875		187,619
	Urban Rail Transportation		2,630				813.67			3,443
	Local Ferries						188.00			188
Total			165,137	0	97,521	78,399	71,003	160,949	4,856	577,865

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Chart below shows the energy consumption distribution for all Monastir's sectors, which can be noted that the energy consumption is distributed equally for residential, industrial and tertiary sectors with percentage of around 20%, whereas the transportation sector took the largest share of energy consumption between all sectors with percentage of 40 %.

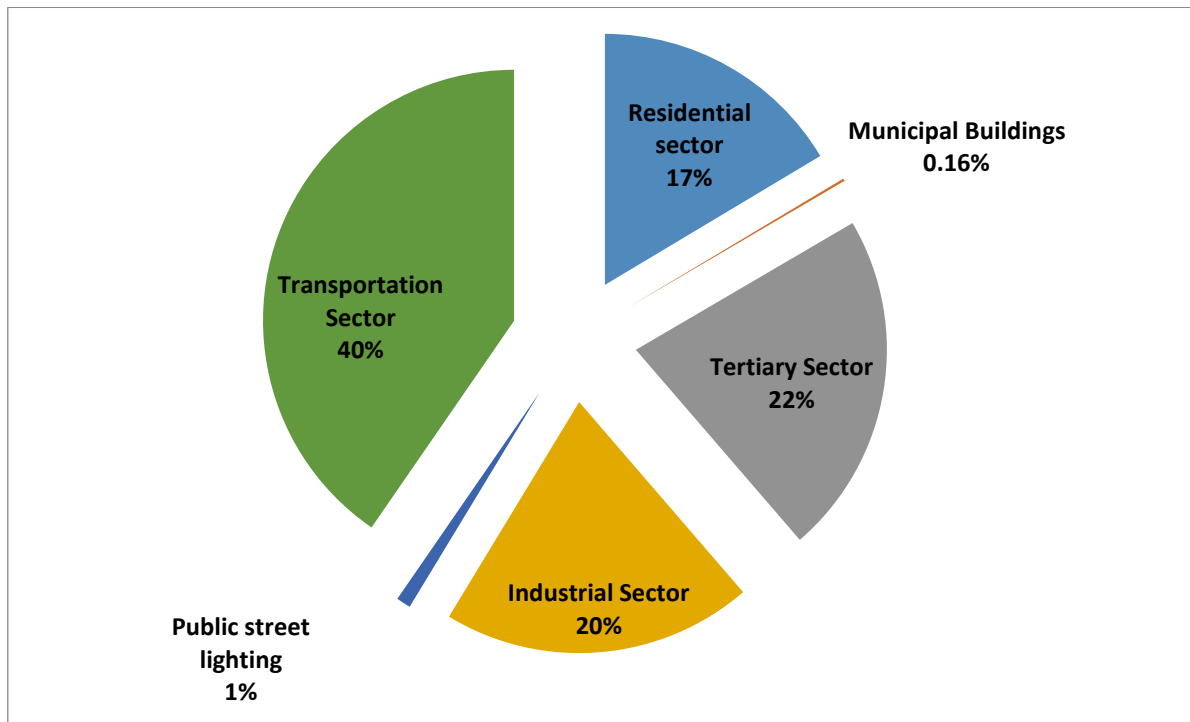


Figure 19: Energy consumption distribution for all sectors in Monastir Municipality

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2.3 Local electricity production

In municipality of Monastir there is no local electricity production except for few small rooftop systems which is not clear the total PV capacity of them.

2.4 CO₂ emissions

2.4.1 Energy related emissions

In the previous sections the energy consumptions in Monastir municipality were described, which the CO₂ emissions can be calculated using the IPCC emission factors.^[9]

Electricity

In order to calculate the local emission factor for electricity, the following equation is used:

$$EFE = \frac{(TCE - LPE - GEP) * NEEFE + CO_2 LPE + CO_2 GEP}{TCE}$$

Where:

EFE: Local emission factor for electricity (tn/MWh)

TCE: Total electricity consumption in the local authority (MWhe)

LPE: Local electricity production (MWhe)

GEP: Green electricity purchased by the local authority (MWhe)

NEEFE: National or European emission factor for electricity (tn/MWhe)

CO₂LPE: CO₂ emissions due to the local production of electricity (tn)

CO₂GEP: CO₂ emissions due to production of certified green electricity purchased by the local authority (tn) [9]

$$EFE = \frac{(165137 - 0 - 0) * 0.602 + 0 + 0}{165137} = 0.602 \text{ tn CO}_2/\text{MWh}$$

Diesel

According to the SECAP guidelines the CO₂ emission factor for the diesel used in vehicles is 0.267 tn/MWh. No biodiesel is being blended.

Gasoline

According to the SECAP guidelines the CO₂ emission factor for gasoline is 0.249 tn/MWh.

Natural Gas

According to the SECAP guidelines the CO₂ emission factor for NG is 0,202 tn/MWh.

Solar thermal

The solar thermal power hasn't emissions thus its emission factor is zero according to the guidelines.

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2.4.2 Non energy related emissions

Apart from the CO₂ emissions released from the daily activities, also there is a significant amount of Greenhouse Gases derived from waste management and waste water treatment plants.

In the Monastir municipality there is a wastewater treatment plant treat the waste water which produced from the municipality, in addition to the municipal solid waste production in the municipality.

Here is the Co₂ emission contribution of the biomass in the municipality:

A- Municipal solid waste

In order to calculate the emissions from municipal solid waste, the IPCC default method was used as it appears below:

$$\text{Methane emissions (Gg/yr)} = (\text{MSWT} \bullet \text{MSWF} \bullet \text{MCF} \bullet \text{DOC} \bullet \text{DOCF} \bullet \text{F} \bullet 16/12 - \text{R}) \bullet (1 - \text{OX}) \dots (1)$$

Where:

- MSWT : total MSW generated (Gg/yr)
- MSWF: fraction of MSW disposed to solid waste disposal sites
- MCF: methane correction factor (fraction)
- DOC: degradable organic carbon (fraction) (kg C/ kg SW)
- DOCF: fraction DOC dissimilated
- F: fraction of CH₄ in landfill gas (IPCC default is 0.5)
- 16/12: conversion of C to CH₄
- R: recovered CH₄ (Gg/yr)
- OX: oxidation factor (fraction – IPCC default is 0)

The IPCC default method assumes that all the potential of CH₄ emissions releases during the same year the waste is disposed of. The method introduces various specific default values and recommendations, for use in countries with lack of statistical data for Solid Waste.

The calculation of the degradable correction factor (DOC) is based on the following equation.

$$\text{DOC} = 0,4 \cdot A + 0,17 \cdot B + 0,15 \cdot C + 0,3 \cdot D \dots (2)$$

Where:

- A Percentage of paper and textiles in SW
- B By Percentage of garden and park waste and other organic putrescibles in SW
- C Percentage of Food waste in SW
- D Percentage of wood and straw waste in SW

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The form of this suggested equation was followed directly because in the case of a Monastir municipality there wasn't a different composition of solid waste. New factors were found in order to calculate the DOC.

The total quantity of solid waste for 2016 was 43,800 tn. The entire amount is thrown in landfill. Waste composition, as well as the results from the calculations is presented in the next two tables.

Table14: Solid waste composition in Monastir, 2016

Solid waste composition	Percentage	tn/a
garden waste	6%	2,628
paper	1%	438
wood	1%	438
glass	1%	438
Organic Waste	80%	35,040
metal	5%	2,190
plastic	3%	1,314
Textiles	1%	438
others	2%	876
Total annual waste in tn	100%	43,800

Table 15: Waste Emissions Calculation factors

Variables	Values
MSW _t :	44
MSW _f :	1
MCF:	0.4
DOC:	0.3347
DOC _f :	0.648
F:	0.5
16/12:	1.3333
R:	0
OX:	0

Where $DOC_f = 0,014 * T + 0,28$ (T: average temperature in Monastir, 26.3°C)

All things considered, 2,500.22tn of methane are released due to the waste management. This quantity equals to 62,505.52tn of equivalent CO₂. (According to the guidelines the factor which was used for the conversion is 25)

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B- Waste Water Treatment Plant (WWTP)

In order to calculate the emissions from WWTP, the IPCC default method was used as it appears below:

$$\text{CH}_4 \text{ emissions} = (U_i * T_{i,j} * EF_j) * (TOW - S) - R$$

Where:

- U_i : fraction of population in income in inventory year
- $T_{i,j}$: degree of utilization of treatment pathways or system
- EF_i : emission factor
- R : amount of CH_4 recovery in inventory year.
- S : organic component removed in inventory year as sludge
- TOW : total organics in waste water during inventory year

The calculation of the emission factor factor (EF_i) is based on the following equation.

$$EF_i = B^\circ * MCF_j$$

where:

- B° : Maximum CH_4 production Capacity
- MCF_j : methane correction factor

and to calculate of the total organics in waste water in inventory year (TOW) is based on the following equation:

$$TOW = P * BOD * 0.001 * I * 365$$

where:

- P : country population
- BOD : country specific per capita BOD
- I : correction factor for additional industrial BOD discharged into sewers

The plant treats daily about 4,174,738 m³ of waste water, and the total quantity of sewage sludge for 2016 was 521.2 tn from the Monastir municipality. Waste composition, as well as the results from the calculations is presented in the next table:

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Table 16: *sewage Emissions Calculation factors*

U_i	0.09
T_{i,j}	0.7
E_{Fi}	0.06
R	0
S	1,428
TOW	5,073

All things considered, 6.99 tn of methane are released due to the waste management. This quantity equals to 174.84 tn of equivalent CO₂. (According to the guidelines the factor which was used for the conversion is 25).

C- Livestock Breeding Sector

In Monastir Municipality there is a small livestock breeding sector. There are cows, camels and sheep breeding in the Municipality.

The table below shows the number of head from each type of livestock in addition to the annual emission factor:

Table 17: *Number of heads and emission factor for livestock breeding in Monastir Municipality.*

Type of livestock	Number of heads	Emission factor (Kg CH₄/year)
Cows	655	1
Camels	15	2.56
Sheep	2350	0.2

All things considered, 1.16 tn of methane are released due to the livestock breeding. This quantity equals to 29.08 tn of equivalent CO₂. (According to the guidelines the factor which was used for the conversion is 25).

2.4.3 Final CO₂ emissions

The emissions of CO₂ equivalent for the sectors that have been described in the previous sections are available, in total, in the following table.

Table 18: Total CO_{2eq} emissions for Monastir Municipality

Sector			Total CO2eq emissions [tnCO2eq/year]								
			Electricity	Heat/cold	Fossil fuels				Renewable energies		Total
					Natural Gas (Low Pressure)	Natural Gas (Medium Pressure)	Diesel	Gasoline	Other biomass	Solar thermal	
Residential sector			32,556		7,259	0	0	0			39,815
Municipal Buildings			541		4	0	0	0			544
Tertiary Sector			48,035		9,435	0	317	0			57,786
Industrial Sector			13,461		3,001	15,837	0	0			32,299
Public street lighting			3,238		0	0	0	0			3,238
Transportation Sector	Urban Road Transportation	Municipal Fleets	0		0	0	530	132			662
		Public Transportation	0		0	0	3,761	13,438			17,199
		Private Transportation	0		0	0	14,083	33,584			47,667
	Urban Rail Transportation		1,583		0	0	217	0			1,800
	Local Ferries		0		0	0	50	0			50
Sub-Total			99,413		19,699	15,837	18,958	47,154			201,060
Non Energy Sources											
Waste Water treatment Plant									175		175
Live stock breeders									29		29
Solid Waste Separation Plant									62,506		62,506
Sub-Total									62,709		62,709
Total			99,413		19,699	15,837	18,958	47,154	62,709		263,769

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2.5 Results' Graphical Analysis

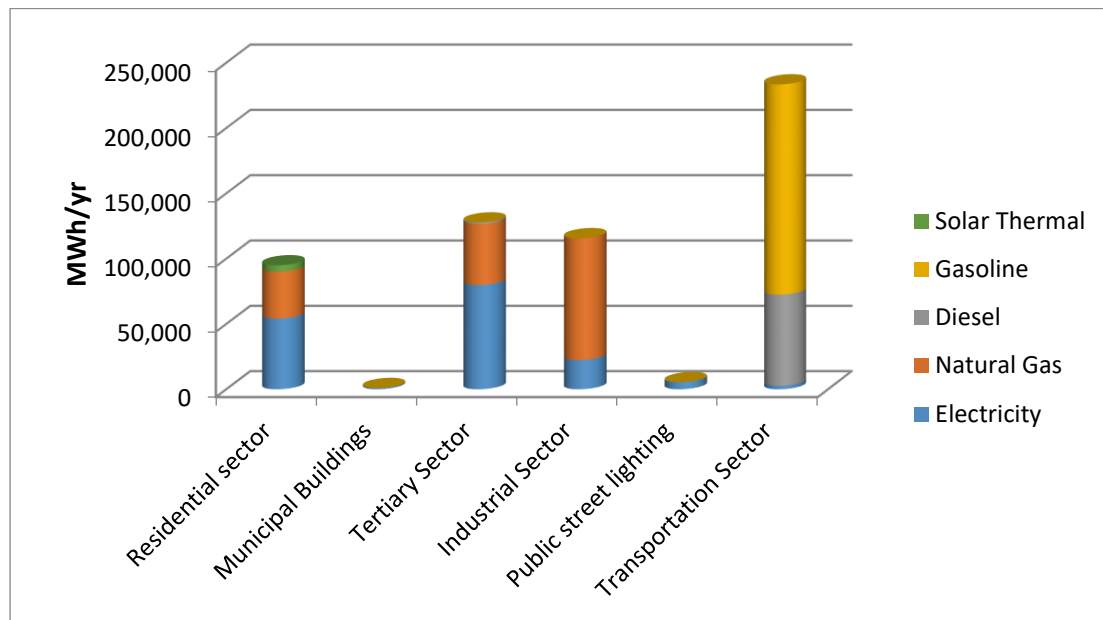


Figure 20: Final Energy consumption per sector and per fuel.

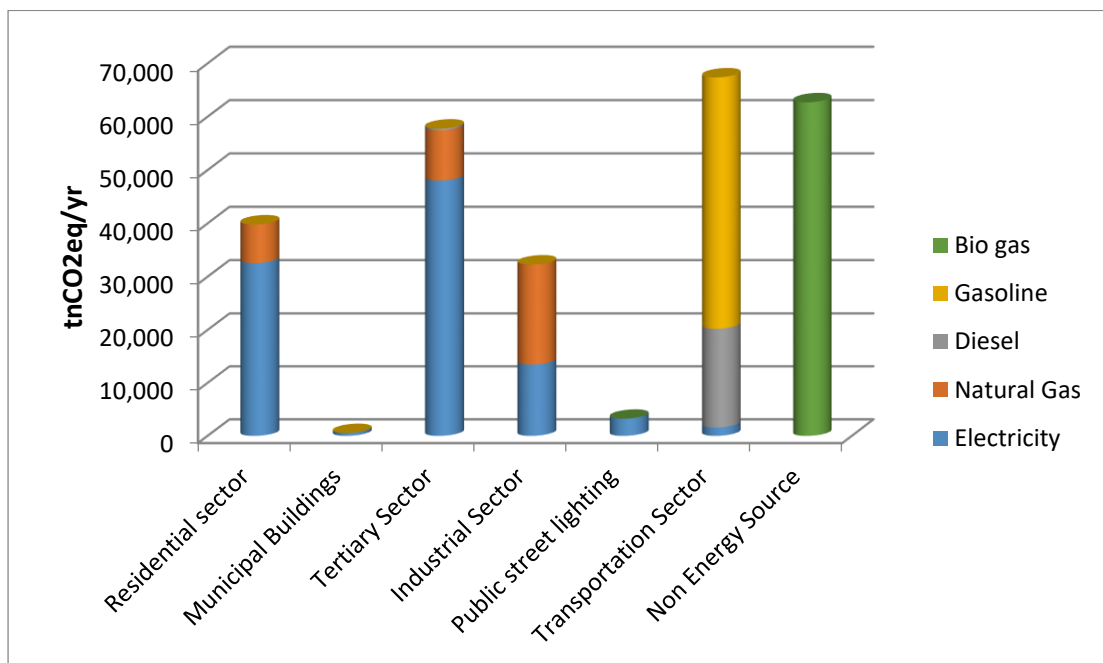


Figure 21: Total CO₂ emissions per sector and per fuel.

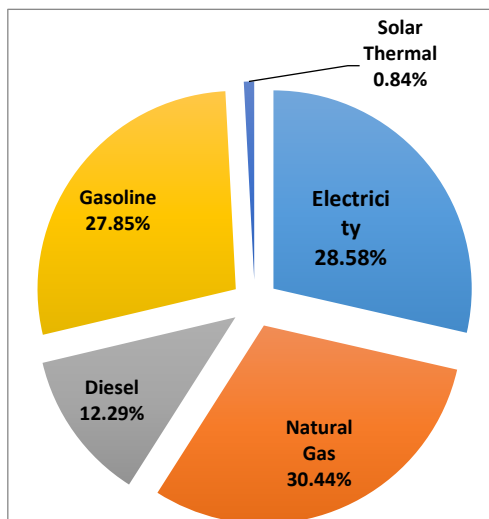


Figure 22: Final Energy Consumption per fuel.

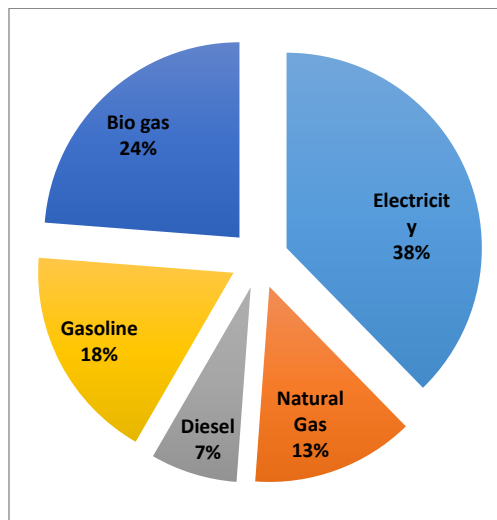


Figure 23: Total CO2 emissions per fuel.

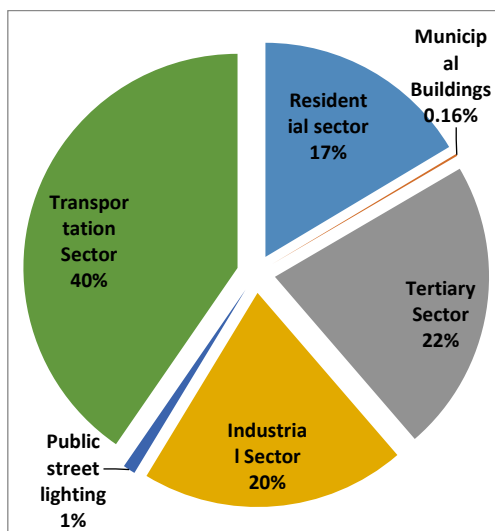


Figure 24: Final Energy Consumption per Sector.

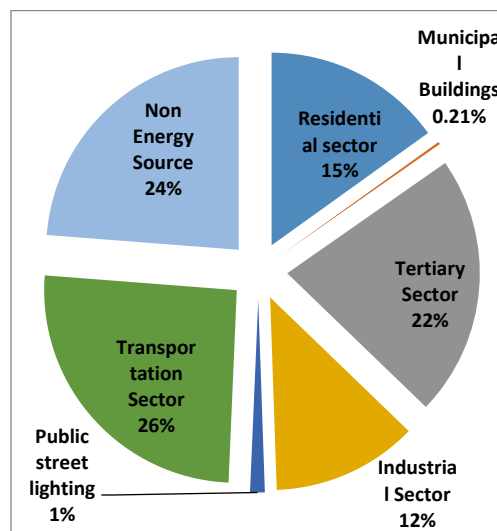


Figure 25: Total CO2 emissions per Sector.

3 Appendices

3.1 Appendix A (Municipal and tertiary Buildings electricity bills data)

	2016		CONSUM MWH MONT HT CONSUM MWH MONT HT PRIME DE PUISSANCE												Total MWh
	Cod.	Ref.	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	
1	2810201	607430	10.3	8.7	10.8	10.2	9.1	9.3	9.9	9.8	11.8	9.6	11.0	9.4	119.9
2	2810310	607260	20.7	17.8	19.9	18.2	18.3	20.9	33.3	31.8	37.5	26.7	23.0	17.2	285.2
3	2810410	605920	16.0	18.3	20.4	16.3	18.5	19.1	21.2	19.6	18.7	15.8	16.3	15.5	215.6
4	2810555	607570	23.8	24.7	23.6	19.2	18.6	12.2	6.2	6.8	10.1	14.7	21.1	15.2	196.1
5	2810625	607590	59.8	68.1	68.4	62.9	54.2	53.8	51.9	48.2	58.8	63.1	73.2	0.0	662.2
6	2810801	607375	11.9	14.9	15.4	11.8	13.0	15.3	17.2	16.4	21.5	19.0	16.1	11.2	183.7
7	2810801	607440	6.8	6.0	6.8	5.1	0.8	12.0	8.4	7.8	10.3	7.1	8.2	5.8	85.2
8	2810811	605330	12.7	12.6	0.4	26.5	0.4	29.4	19.2	17.4	15.2	0.4	16.7	14.0	165.0
9	2810811	605331	0.0	1.6	2.3	2.0	1.9	3.0	3.0	2.6	5.9	17.6	44.0	50.1	133.8
10	2811001	600040	57.6	50.4	46.0	41.9	37.8	0.0	80.9	39.4	53.4	45.6	0.0	0.0	453.1
11	2811001	607080	7.2	6.8	6.1	4.8	5.5	4.6	4.5	5.4	5.0	6.1	9.0	9.3	74.4
12	2811105	607370	8.4	3.9	5.3	3.9	0.2	8.5	6.2	5.1	5.1	0.2	0.2	10.5	57.6
13	2811611	601120	1.8	0.2	2.0	1.2	1.5	0.7	0.6	0.6	0.6	0.6	0.6	0.4	10.9
14	2811710	597520	5.3	6.7	6.0	6.4	6.4	0.2	17.5	8.0	8.0	1.0	1.5	0.9	67.9
15	2811710	600010	7.1	5.3	2.5	2.6	2.1	1.1	0.5	0.5	0.5	0.5	0.5	0.5	23.8
16	2811710	603570	1.0	1.5	1.6	0.9	1.5	0.9	0.8	0.9	0.8	0.7	0.8	0.8	12.2
17	2812005	608757	75.4	61.3	69.7	53.5	54.5	41.9	56.4	36.4	56.1	50.0	59.3	54.6	668.9
18	2812370	608450	20.5	20.6	18.2	15.9	13.5	10.4	20.4	16.3	11.2	17.0	17.2	17.6	198.8
19	2812510	608070	5.2	6.6	8.7	6.7	5.7	2.7	8.2	8.8	17.5	5.8	6.9	6.7	89.6
20	2812710	607170	2.9	3.6	3.5	3.1	3.3	3.7	4.9	5.1	5.5	4.8	4.1	3.5	47.9
21	2812713	601740	6.2	6.0	5.2	3.6	3.6	6.3	7.9	9.1	9.0	4.7	4.3	6.4	72.1
22	2812714	590531	21.6	15.5	17.4	10.5	10.6	14.9	19.5	23.5	17.0	13.3	12.0	17.0	192.9
23	2812715	588150	7.7	6.2	5.8	2.5	2.3	2.5	3.7	4.1	3.7	2.6	3.0	7.2	51.3

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24	2812717	603700	4.7	4.2	3.7	2.2	2.5	3.8	5.8	7.5	5.3	3.1	3.0	3.9	49.8
25	2812790	607290	239.9	212.2	278.0	219.4	243.7	308.0	441.7	401.3	468.2	336.4	0.0	475.2	3,623.9
26	2812790	607310	29.7	31.6	36.0	22.6	26.2	43.5	72.1	63.7	74.6	49.0	35.6	29.4	513.9
27	2812790	607633	87.9	76.8	83.6	73.1	77.6	117.3	144.1	139.1	145.4	109.2	93.7	70.6	1,218.4
28	2812912	603410	3.7	3.8	3.5	3.3	3.3	2.7	2.8	2.5	2.6	3.4	4.6	4.4	40.6
29	2812914	591100	1.9	1.4	1.8	1.7	1.2	1.0	0.5	0.4	1.0	1.6	2.0	1.7	16.2
30	2812916	597610	3.3	3.6	2.8	2.6	2.0	1.0	0.8	0.7	0.2	3.1	2.3	3.1	25.5
31	2812917	584110	1.7	1.5	1.4	1.5	1.2	0.2	1.1	0.6	1.0	0.9	0.2	3.5	14.8
32	2812918	597550	3.9	3.2	0.4	4.8	2.1	0.4	0.4	0.4	0.4	6.5	2.9	0.4	25.7
33	2812922	607450	11.8	11.5	10.3	6.9	7.3	6.8	5.6	7.0	9.8	8.9	10.5	10.8	107.1
34	2812923	607330	6.1	6.6	5.4	4.8	5.6	3.5	2.1	1.7	3.8	4.8	7.7	5.5	57.6
35	2812924	601760	3.0	3.6	2.4	2.5	1.8	1.2	0.9	0.8	1.9	2.4	2.9	3.5	27.0
36	2812927	588300	2.1	1.5	1.8	2.1	2.2	1.9	2.0	1.8	1.8	2.5	2.4	2.4	24.6
37	2812928	603400	3.1	2.5	2.5	2.6	2.7	1.4	1.0	1.1	1.8	2.4	3.6	3.5	28.1
38	2812940	590390	1.3	1.4	1.3	1.3	1.3	0.8	0.8	0.8	1.0	1.4	1.6	1.5	14.5
39	2812941	584490	2.2	2.2	1.7	2.0	1.9	0.4	1.8	1.1	1.6	1.3	2.4	2.6	21.3
40	2812945	590095	1.7	1.9	1.5	1.7	0.4	2.5	0.8	1.1	1.4	1.7	0.4	3.9	18.8
41	2812953	607445	3.8	3.4	3.4	3.2	3.0	1.8	1.7	1.6	2.6	2.4	4.4	3.4	34.7
42	2812957	604240	10.1	11.3	8.6	11.4	10.4	9.9	4.1	3.2	7.9	10.1	11.3	10.2	108.6
43	2813014	607241	10.9	15.7	13.6	12.3	15.8	17.9	19.2	16.5	17.2	13.2	14.1	11.6	177.9
44	2813015	607085	13.3	16.7	7.3	21.7	16.0	12.1	11.2	9.5	20.4	27.0	21.4	15.3	191.9
45	2813022	607014	7.7	8.7	7.3	7.9	7.7	8.8	9.0	9.0	10.6	8.6	8.5	7.4	101.2
46	2813025	607560	9.1	10.7	8.8	8.9	9.1	7.6	3.5	6.8	8.7	10.3	11.3	7.2	102.3
47	2813026	606100	25.6	25.5	28.0	22.1	23.0	12.2	9.8	8.9	12.6	20.9	25.8	19.7	234.1
48	2813026	606130	3.3	3.3	3.8	2.6	2.4	1.0	0.7	0.3	1.2	1.8	3.0	3.0	26.2
49	2813027	606105	5.6	5.5	5.8	5.8	7.1	5.4	2.3	2.6	6.3	7.5	7.3	4.4	65.7
50	2813028	607190	10.8	11.8	10.1	8.8	10.1	6.8	7.1	7.0	7.2	8.2	11.0	7.4	106.2
51	2813029	607180	27.1	32.0	25.0	23.8	28.8	15.7	15.2	5.5	20.5	24.6	30.9	19.5	268.7
52	2813040	607087	7.9	9.0	8.1	8.0	8.1	6.7	4.2	4.1	5.3	8.4	11.3	8.2	89.3
53	2813050	607575	5.6	5.9	5.1	5.2	4.3	4.0	3.8	4.0	5.5	6.7	5.5	4.3	59.8
54	2813053	607160	22.3	25.2	25.3	19.3	15.7	9.6	18.0	20.2	29.9	25.7	18.5	18.1	247.9
55	2813056	607580	35.3	38.9	35.1	32.8	32.0	30.3	28.0	22.8	36.1	33.9	40.0	29.4	394.6

BEI Report for the Municipality of Monastir

56	2813059	607140	33.2	43.3	38.4	32.1	31.5	26.4	31.6	32.3	42.6	37.9	36.8	28.7	414.8
57	2813060	607015	15.7	19.1	16.9	13.8	14.2	12.2	11.0	10.5	16.0	14.5	18.1	15.4	177.3
58	2813061	607120	15.9	20.5	18.3	13.9	13.1	11.9	20.2	14.7	21.4	19.0	19.2	14.4	202.6
59	2813061	607125	15.0	17.9	18.2	15.0	14.7	19.5	25.5	28.6	29.2	24.4	17.5	12.9	238.6
60	2813113	589700	3.9	4.2	4.9	3.4	3.4	2.0	4.3	3.1	3.4	3.3	3.4	3.8	43.1
61	2813114	597280	0.3	0.7	0.5	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	3.6
62	2813173	607510	23.1	25.6	21.5	22.7	23.5	16.1	9.4	6.7	14.9	18.5	26.9	23.2	232.0
Total public administration buildings			1,103	1,092	1,118	980	960	1,008	1,326	1,173	1,425	1,193	871	1,168	13,417
63	4810006	593380	0.2	0.2	0.3	6.9	0.2	0.2	0.5	0.8	1.3	1.3	1.7	2.3	16.0
64	4810009	589290	0.7	1.3	3.2	2.6	2.6	2.6	2.6	2.6	2.8	2.9	2.3	3.0	29.2
65	4810010	604010	2.0	2.3	3.3	2.6	2.4	2.3	2.3	2.2	2.9	2.8	3.1	3.1	31.2
66	4810010	605510	3.4	3.1	3.8	3.3	3.1	2.7	2.5	2.4	2.5	2.3	3.6	5.2	37.9
67	4810010	605930	9.2	7.1	7.5	6.3	5.6	4.2	6.8	5.7	8.2	9.3	0.7	0.7	71.3
68	4810010	606270	6.3	6.5	7.1	5.3	5.4	4.1	4.8	4.8	6.0	5.8	6.3	7.2	69.7
69	4810010	606350	3.2	3.7	3.7	3.3	3.5	3.0	3.2	3.2	3.5	3.2	3.2	3.0	39.8
70	4810010	607490	4.3	4.2	4.8	4.2	3.9	3.2	2.0	2.9	3.7	4.3	6.0	5.0	48.4
71	4810010	607500	13.7	14.5	23.7	20.9	24.6	24.8	22.8	21.7	24.0	25.0	31.9	23.7	271.3
72	4810010	607502	1.0	1.0	14.0	1.0	1.0	4.6	3.4	2.3	4.3	5.5	1.2	1.0	40.4
73	4810010	608060	0.8	0.1	0.2	1.3	1.4	1.1	1.3	1.3	1.5	1.6	1.7	1.6	13.9
74	4810010	608290	9.8	0.3	9.1	3.6	3.9	2.9	3.7	3.0	3.2	4.0	6.0	3.8	53.3
75	4810010	608660	2.5	2.3	2.4	2.1	2.5	1.9	2.0	1.4	1.6	1.9	2.1	1.7	24.6
76	4810010	608740	1.9	1.8	1.8	1.5	1.5	1.1	1.5	1.1	1.1	1.4	1.5	1.4	17.7
77	4810010	609030	4.3	4.6	4.7	4.2	6.3	6.4	7.0	5.2	7.1	6.2	6.0	6.5	68.4
78	4810021	601800	3.8	3.8	3.6	2.9	2.2	3.1	3.1	3.1	2.8	2.5	2.9	2.9	36.7
79	4810022	586180	3.3	2.4	2.4	2.4	2.2	1.9	1.9	2.1	0.2	4.1	2.9	2.4	28.1
Buildings related to municipality			71	59	96	74	73	70	71	66	77	84	83	75	898
80	5810001	586115	0.2	1.0	4.3	4.9	0.3	1.3	4.2	2.5	0.2	7.1	0.2	0.2	26.6
81	5810001	586210	7.7	7.6	8.8	10.1	7.4	14.4	13.0	15.0	0.3	11.7	3.8	1.0	100.9
82	5810002	586450	7.1	6.6	8.4	13.4	10.5	8.8	9.4	8.1	0.2	11.1	4.7	0.6	89.0
83	5810003	584420	5.0	3.7	3.2	8.9	6.2	6.6	7.1	5.2	3.8	1.6	3.0	0.9	55.1

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84	5810005	586100	0.3	17.1	9.0	12.1	9.6	13.4	14.9	13.6	11.3	2.1	4.0	1.3	108.7
85	5810006	586120	0.6	3.9	4.6	9.6	3.7	4.4	15.4	10.1	0.2	8.2	1.2	0.3	62.3
86	5810007	586131	4.7	6.3	8.6	11.7	8.1	13.1	13.2	10.5	0.4	0.2	19.2	0.6	96.6
87	5810008	586200	6.8	9.1	12.2	22.5	15.7	17.3	20.7	14.7	0.2	8.0	3.0	0.8	130.8
88	5810009	586400	2.3	3.1	4.3	9.5	6.0	8.3	8.5	9.0	6.4	4.1	1.6	0.9	64.1
89	5810011	588480	5.9	5.2	9.0	6.6	4.6	0.2	6.2	8.5	6.4	4.3	3.8	0.8	61.6
90	5810012	588650	5.2	5.9	13.0	11.6	3.9	2.3	5.6	6.6	2.5	0.2	6.5	1.0	64.3
91	5810014	590750	1.3	3.2	2.5	3.7	1.8	3.6	6.2	3.3	6.0	0.9	0.6	0.4	33.4
92	5810015	593020	5.4	6.7	9.5	8.4	5.5	9.3	8.5	9.1	2.7	1.3	1.5	1.0	69.0
93	5810016	593050	1.9	2.2	3.1	3.6	2.4	4.1	3.9	4.3	0.2	0.8	1.2	0.6	28.1
94	5810017	593530	8.4	12.7	15.7	15.9	12.5	0.2	32.1	17.3	0.2	13.7	6.4	2.7	137.9
95	5810019	593640	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.5
96	5810019	593650	15.3	19.9	25.0	29.0	17.3	28.7	22.8	23.2	14.5	6.3	11.3	4.5	217.6
97	5810020	593700	2.6	3.7	6.3	2.7	5.0	28.7	22.8	23.2	4.0	6.3	1.7	0.7	107.5
	Agricultural		81	118	148	184	121	165	214	185	60	88	74	19	1,455
98	6810014	590050	3.3	3.2	3.7	2.6	3.2	2.5	2.8	2.9	2.6	3.0	2.8	0.2	33.0
99	6810014	605750	2.2	2.1	2.1	0.8	0.4	0.4	0.4	0.5	0.4	0.5	0.6	0.6	11.1
100	6810050	586220	22.4	19.7	16.8	21.6	22.1	23.4	23.0	24.5	23.0	18.9	24.2	19.3	258.9
101	6810055	607470	3.1	2.9	3.5	2.8	3.2	4.2	4.9	5.8	6.6	4.8	3.7	2.4	47.9
102	6810116	603310	4.2	4.8	4.1	4.5	4.9	3.7	1.5	2.6	3.7	3.8	4.1	3.6	45.3
103	6810520	593080	0.2	0.2	0.2	0.2	0.2	1.2	0.2	0.3	0.2	0.2	0.2	0.2	3.7
104	6810520	593145	0.7	0.6	0.7	0.2	1.1	0.9	0.8	0.8	0.2	0.2	0.5	0.4	7.0
105	6810520	593440	1.7	1.7	1.4	1.3	1.3	0.5	0.4	0.8	0.2	1.0	1.1	0.2	11.6
106	6810520	607030	16.4	18.0	21.4	18.7	20.2	18.6	18.5	18.1	19.3	16.6	20.4	18.4	224.6
107	6810520	608720	10.1	10.1	9.8	9.8	11.1	7.6	8.7	6.4	6.7	8.7	10.9	11.0	110.9
108	6810520	608730	0.5	0.5	0.6	0.9	1.4	1.2	1.4	1.2	1.7	1.6	1.5	1.8	14.2
109	6810520	608735	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.7	0.5	0.5	5.7
110	6810520	609471	0.0	0.0	0.0	9.6	69.1	84.6	65.4	70.5	88.8	58.4	44.8	53.5	544.5
111	6810552	584251	5.4	4.8	4.0	5.1	2.0	1.4	1.5	1.8	0.0	2.2	2.0	4.2	34.5
112	6810555	588340	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.8
113	6810555	600480	1.8	1.7	2.1	1.8	1.4	1.5	1.3	1.4	1.6	1.5	3.4	2.3	21.9
114	6810555	600490	1.2	1.0	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.2	1.1	13.3

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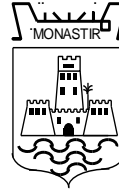
115	6810801	607320	4.1	4.2	4.1	3.6	3.6	3.9	6.0	6.6	7.6	5.7	4.0	3.1	56.5
116	6810804	608480	1.8	1.7	2.0	2.1	2.4	2.1	3.5	3.2	3.5	2.8	2.2	2.3	29.6
117	6810805	607520	3.7	2.7	3.3	2.2	2.1	4.1	5.8	5.4	5.9	4.2	2.4	2.3	44.1
118	6810817	607350	10.2	9.8	10.8	6.9	7.6	7.9	12.0	12.4	14.4	9.8	8.4	8.3	118.5
119	6810820	583650	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.8	0.4	0.4	2.7
120	6810820	584050	0.6	0.4	0.5	0.4	0.4	0.4	0.5	0.5	0.8	0.7	0.8	0.7	6.8
121	6810820	584240	0.2	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.0	0.5	0.3	0.3	3.2
122	6810820	597780	0.3	0.3	0.3	0.3	0.3	0.1	0.6	0.3	0.3	0.1	0.6	0.1	3.8
123	6810820	607360	10.5	10.2	10.4	9.3	9.1	10.1	13.4	13.0	16.1	12.1	12.6	9.3	136.1
124	6810833	601540	209.7	221.4	185.5	170.7	134.6	243.4	124.0	232.9	274.6	364.6	187.6	166.8	2,515.7
125	6810833	601580	5.2	5.8	4.7	4.2	4.3	5.2	4.4	5.8	6.4	8.6	4.3	4.7	63.5
126	6810833	608260	7.1	11.7	17.6	14.4	25.4	17.3	33.6	26.8	18.7	7.4	5.2	7.9	193.2
127	6810833	609050	1.5	1.0	3.0	3.3	5.3	4.4	9.4	5.5	0.4	15.8	1.7	8.3	59.6
128	6810841	584010	63.1	52.0	66.8	43.7	32.2	20.3	1.3	1.3	1.3	1.3	122.2	98.6	504.2
129	6810841	606390	4.0	4.5	4.3	3.8	4.0	3.6	4.9	5.3	5.5	4.3	4.0	3.7	51.9
130	6810901	584210	5.2	4.6	5.6	4.6	3.6	4.6	5.3	5.3	6.0	4.3	5.6	5.2	60.1
131	6810901	606210	2.2	2.2	2.6	2.1	2.4	2.1	2.9	2.7	2.7	2.8	2.2	2.1	29.1
	Governmental companies		403	404	394	354	381	484	361	467	521	569	487	444	5,269
132	9811000	604050	6.9	5.2	10.5	8.7	10.0	9.6	12.9	10.5	7.8	6.9	10.4	17.0	116.3
133	9811000	604200	3.2	1.6	4.4	3.4	3.9	2.9	3.8	2.2	0.9	0.4	1.4	0.4	28.6
134	9811000	605070	0.0	406.5	245.1	207.8	225.5	170.5	213.5	193.9	189.0	156.5	162.9	142.9	2,314.0
135	9811000	605810	0.7	0.8	0.9	0.8	0.9	0.9	0.9	1.1	1.4	1.4	1.7	1.9	13.5
136	9811000	607050	14.9	2.6	0.2	0.2	0.2	11.0	0.2	6.0	0.2	0.2	0.2	11.3	46.8
137	9811000	607390	8.6	6.6	8.4	6.5	0.4	11.9	8.1	7.7	9.1	0.4	16.6	10.8	95.2
138	9811000	608040	14.2	10.4	10.0	9.6	11.0	8.7	10.3	13.0	12.8	16.3	23.3	33.6	173.1
139	9811000	608440	1.9	0.2	3.9	2.1	2.5	0.2	4.5	2.5	2.8	2.8	2.2	2.7	28.2
140	9811000	608600	9.4	8.9	10.6	8.8	10.7	8.9	11.3	10.2	10.1	12.9	14.4	10.2	126.3
141	9811000	608680	2.5	3.7	4.4	4.4	10.6	8.9	12.6	11.9	13.6	14.0	5.4	9.9	101.8
142	9811000	609080	0.9	0.9	0.9	0.9	2.2	2.0	2.8	2.8	3.2	3.2	1.5	2.2	23.6
143	9811000	609150	0.1	4.0	1.8	1.8	2.7	1.6	1.9	1.8	1.9	1.7	1.0	1.1	21.3
144	9811000	609310	0.5	0.5	0.6	0.7	1.1	1.3	1.5	1.4	1.5	1.2	1.2	1.8	13.1

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	water treatment stations		64	452	302	256	282	238	284	265	254	218	242	246	3,102
145	9810900	607610	38.0	37.6	41.7	38.4	41.7	48.9	41.7	37.8	43.3	42.8	46.4	34.0	492.4
	water Pumping		38	38	42	38	42	49	42	38	43	43	46	34	492

3.2 Appendix B (Public lighting study report)

المنستير في 31 مارس 2013



الجمهورية التونسية
وزارة التنمية المحلية
بلدية المنستير

* * *

من مكرم بنكریم تقني أول

رئيس مصلحة الأشغال المباشرة والصيانة

إلى السيد رئيس النيابة الخصوصية لبلدية المنستير

الموضوع : دراسة عامة حول شبكة التوزيع العمومي لبلدية المنستير
و بعد أتشرف بأن أعرض على سيادتكم معطيات عامة حول شبكة التوزيع العمومي لبلدية المنستير

تقديم عام:

نسبة %	عدد الفوانيس سنة 2016	نسبة %	عدد الفوانيس 2005	نوعية الفوانيس
44.75	3100	51.03	3440	مركير 125 واط
27.62	1900	34.12	2300	مركير 250 واط
4.14	750	0	-	صوديوم 150
22.09	2840	14.83	1000	صوديوم 250
1.38	100	0	-	صوديوم 70
	8590		6740	الجمالي
	5.377,670		6.430,000	القيمة الاستهلاكية للواط
	1 227.366,945		630.524,000	فاتورة الإستهلاك

- أسلاك كهربائية تحت أرضية : تعدّ 260 كلم
- أسلاك كهربائية هوائية تعدّ 350 كلم
- ع 156 عدد نقطة تزود بالطاقة في انتظار إضافة عدد 24 عدد كهربائي
- ع 18 عدد نقطة تزود بمحولات كهربائية هوائية (Poste transfo Aérien)
- ع 82 عدد معدّل ضغط جهد بتكلفة 600 ألف دينار معطوبة

*جدول الإمكانيات ماديّة وبشريّة المتوفرة

سنة	الاعتمادات المرسمة أد	الكثافة السكانية	إجمالي الشبكة نقطة إنارة	عدد العمال المختصة في التنوير	الآليات الموضوعة على الذمة
1998	73.000	63000	3800	7	2-شاحنة سلم - سيارة إدارية
2014	156.000	93306	8590	3	1-شاحنة سلم معطوبة

*جدول توزيع في نسب الإنارة حسب التقسيم الديمغرافي والكثافة السكانية بمدينة المنستير:

الموقع	عدد المساكن	عدد العائلات	نسبة السكان المتمتعة بالإنارة %	التكلفة لتغطية النقص بالدينار
المدينة الأولى	6106	4812	70	240.000

الحاية	11619	9260	75	335,000
سقانس	11397	8249	45	500,000
المدينة الثانية	5481	4146	55	216,000
الجملة:	34603	26467		1291 م د

1- الأهداف

- أدرج مقاييس الحماية الواجب تطبيقها في الشبكة القديمة
 - تأهيل شبكة التوزيع العمومي
 - تمديد الشبكة لبلوغ عدّة نقاط سوداء في المناطق السكنية
 - صيانة المحولات الكهربائية
 - تقليص من الاستهلاك للطاقة الكهربائية
 - تقليص العقوبات المسلطة من طرف STEG
- لتحقيق هذه الأهداف والعمل على التقليل من ميزان الدفوعات ,مع تحسين في المردودية فالمقترح (اعتماد السياسة المرحلية) في توفير الاعتمادات.

1.1- أدرج مقاييس الحماية

- *تدعيم الشبكة بالقواطع الكهربائية التفاضلية.
- *تمديد الخط الأرضي.
- *حملة شاملة لأغلق أبواب الحاويات والعدادات الكهربائية الراجعين لبلدية المنستير.

1.2- تأهيل شبكة التوزيع العمومي

- *تعديل الأقطاب الكهربائية بتمديد الأسلاك الكهربائية اللازمة لذلك.
- *أضافه عدادات كهربائية وتركيزها في شبكة التوزيع العمومية الداخلية.
- *أعادة صيانة وتركيز الأعمدة المزالة أثر حوادث مرور.

*تغير مرحلي لنوعية وتقنية المعدات الكهربائية في الشبكة .

1.3- تمديد الشبكة

* أشغال تركيز نقاط تنوير إضافية لبلوغ النقاط السوداء في الشبكة مع مراعات مقاييس الحماية والحفاظ على تعديل الأقطاب.
* الصيانة الدورية تبع لبرنامج شهري لفرق صيانة التنوير العمومي.

1.4- صيانة المحولات الكهربائية

* أدراج الاعتمادات اللازمة في الميزانية للقيام بالصيانة الدورية والسنوية للمحولات الكهربائية لما تمثله من أهمية في تزويد شبكة التنوير العمومي وتأثيرها على فواتير الخالص.

1.5- تقليص من الاستهلاك للطاقة الكهربائية

* أدراج برمجية توقيت تشغيل الأقطاب والتحكم في ساعات عمل شبكة التنوير العمومي
*استغلال الطاقة المتجددة في التقليص من الطاقة الاستهلاكية واستغلال الحلول التقنية والتكنولوجية المتوفرة لبلوغ الربحية القصوى.
مع الإشارة أنه تبعا للدراسة الأولية التي قمت بها حول تركيز اللوحات للطاقة الشمسية واستغلالها لتسقيف السوق الأسبوعية لبلدية المنستير مع تركيز نوع خاص من بطاريات شحن الطاقة الكهربائية يمكننا في ظرف أربع سنوات استرجاع الأموال المصروفة والتي تقدر قرابة 3 مليون دينار والدخول في الربحية المادية التي تصل الى 6مليون دينار على أقل تقدير وذلك على أثر بيع الطاقة الكهربائية المخزنة الى الشركة التونسية للكهرباء والغاز وبذلك نتحول من مستهلك الى مستهلك منتج للطاقة.

1.6- تقليص العقوبات المسلطة من طرف STEG

*تركيز بطاريات مكثفة للطاقة

الميزانية المقترحة إدراجها 2020/2016
بالآلف دينار

2020	2019	2018	2017	2016	
-	50	50	50	50	تجديد الأسطول
150	150	150	150	-	تهيئة الشبكة
850	850	850	850	-	تركيز لوحات شمسية
250	250	200	200	250	صيانة عادية
150	150	150	150	150	تمديد الشبكة
-	35	-	-	35	سيارة للمصلحة
-	-	-	-	3	دراجة عادية
-	-	-	-	2	حاسوب
-	-	-	-	0,2	مكتب حاسوب
-	-	-	-	0,5	تطبيق إعلامية
1400	1485	1400	1400	490,7	الجملة :

نظرا لما تمثله صيانة شبكة التوزيع العمومي من أهمية خاصة لحجم الدفعات التي فاقت 2 مليون دينار و لأهمية ما تتطلبه الحملات الخاصة لصيانة شبكة التوزيع العمومي من جهود للتقليص في ميزان الدفوعات المقترح

- * إعادة تنظيم وهيكله مصلحة التوزيع .
- * أنتداب أعوان اختصاص للعمل في فريق التوزيع العمومي .
- * رسكلة دورية لأعوان المصلحة .
- * تدعيم فرق الصيانة الكهربائية .
- بعمال قارين في اختصاص الحدادة والبناء.
- توفير 3 شاحنات سلم جدد
- توفير 2 شاحنة خفيفة
- * توفير وأرساء منظومة وأليات متابعة ومراقبة لفواتير الاستهلاك الكهربائي والعدادات و العمل الميداني لأعوان التدخل و الصيانة.

أعلمنا سيادتكم بهذه المعطيات للتفضل بالإحاطة.

3.3 Appendix C (Public and Private Transportation)

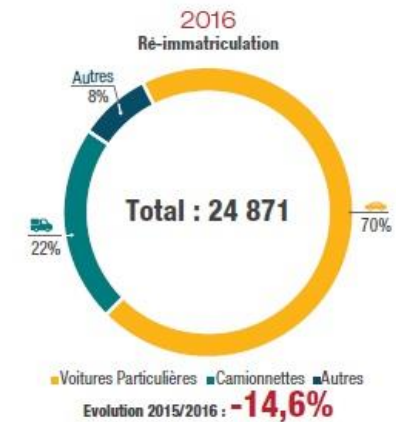
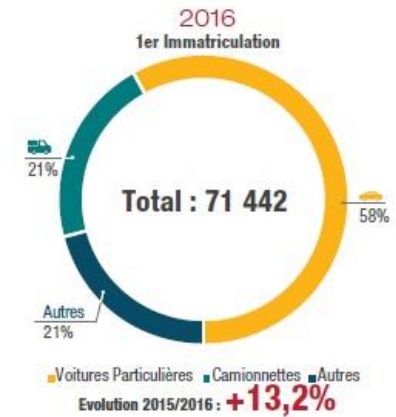
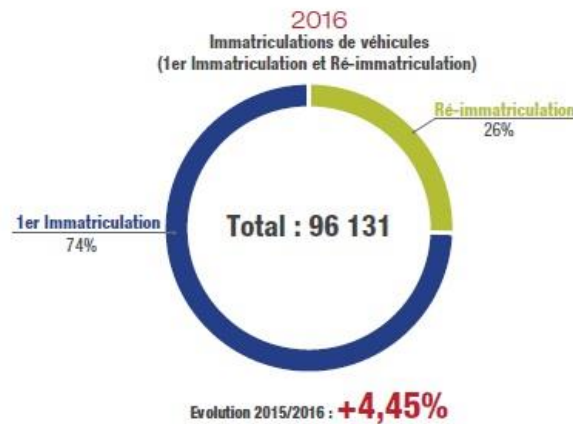
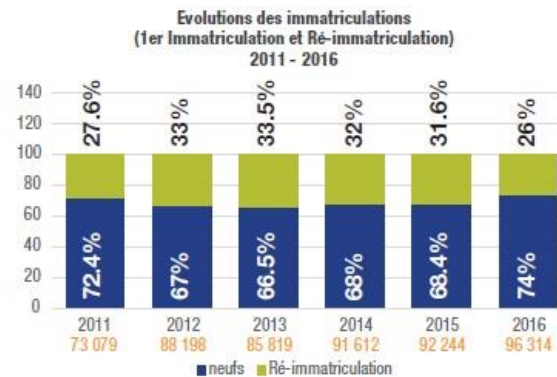
Vehicle Type	Number of vehicles passing the monastir municipality borders	Daily Fuel consumption per vehicle (Lit/day)	Annual Diesel Fuel consumption (Lit/yr)	Annual Gasoline Fuel consumption (Lit/yr)	Diesel (MWh)	Gasoline (MWh)	Total (MWH)
Buses			874,000		8,740	0	39,631
Taxis	600	12		2,628,000	0	25,544	
Louage (within the district border)	28	25	255,500		2,555	0	
Louage (outside the district border)	51	15	279,225		2,792	0	
Total	628		1,408,725	2,628,000	14,087	25,544	

Vehicle Type	Vehicle at national level	Vehicle at municipal level	MPG	Lit/km (@ 50 km/hr)	Lit/hr (@ 50 km/hr)	fuel type	driving time within Monastir Region plus stops (hr)	Total fuel consumed (Lit/day)	Annual Gasoline consumed (1000 Lit/year)	Annual Diesel consumed (1000 Lit/year)
Motorcycles	9,513	3,000	50	0.047	2.353	Gasoline	0.75	5,294	1,652	
Passengers Cars	1,217,236	10,632	22.5	0.105	5.229	Gasoline	0.75	41,694	13,009	
Pick-up	8,875	69	16.2	0.145	7.262	Diesel	0.75	376		98
Cargo Vehicles	442,029	3,448	16.2	0.145	7.262	Diesel	0.75	18,780		4,883
Van	9,184	72	16.2	0.145	7.262	Diesel	0.75	392		122
2-axle Truck	18,551	16	8.8	0.267	13.369	Diesel	0.75	162		21
Trailers	117,702	51	5.9	0.399	19.940	Diesel	0.75	769		100
Construction Vehicle	10,620	47	5.9	0.399	7.976	Diesel	0.75	278		36

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Agricultural Vehicle	93,456	20	5.9	0.399	7.976	Diesel	0.75	118		2
Ambulance/Civil defense Vehicles	1,095	10	22.5	0.105	5.229	Diesel	0.75	39		12
total	1,928,261	17,365						67,902		5,274

Tunisie-Parc Automobile (au 31/12/2016)



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