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The Opportunity of Using Wind to Generate Power as a Renewable Energy:"Case of Kuwait”

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Abstract
The demand ofsustainable energy is increased daily by expanding our cities and creating new cities and suburbswith huge towers besides increasing in population,moreover the environment and human life is threatening by the pollutions resulted from energy generation. For this reason the researchersattracted todevelop renewable energy and explore its large benefits and unit capacity.
Wind power is one of the clean renewable energy resources.Therefore the importance of implementing this resource in Kuwait draws our attention to make this research to emphasis on the technical and economic aspects due to acceptable environmental conditions. Whereas, in some areas of the world, such as in Japan, has some geographical and electrical restrictions such as power fluctuating for land wind generation. And the introductionof large amount of wind power generation tends to be extremely difficult and even impossible in some location.
This research is aimed to concentrate on the visibility of utilizing the wind energy as complementary source for the existing steam and gas turbine power stations in Kuwait, furthermore point out the economical perspectives that will guide us to take the right decision. The location of wind farms is very important in this aspect where we cannot build such projects inside the cities between buildings besides meeting the minimum requirements for economic generation.
The study prove to us that even at a location which is almost close to the inhabitants buildings (Kuwait airport) can get accepted results the historical data was collected from the weather station at internet.
The implementation of wind turbine farms is foreseen to be economic in generation for long run and encouragestepping up toward putting the infrastructure design. Furthermoreit is an opportunity for creating new job vacancies.
Keywords : Wind power, Wind Turbine, Renewable, Energy, Economic, Sustainable, Kuwait, Power Generation .

I. Introduction

A rapid increasing in energy demand with the limited natural resources create a challenge of providing energy in a clean and safe way coupled with economical productivity. Consequently, starting to think how to produce and use a renewal clean energy and also saving energy in high efficiency and sustainable way [1]. An economical wind power generation of large scale farms developed very fast, at the same time different obstacles is facing us to build up these generators;one of the major barriers is a geographical obstacle which is one of the important factorsthat depend on the nature of the land and the wind speed.
The demand of sustainable energy is increased daily by expanding the cities and creating new cities and suburbs with huge towers besides increasing in population, moreover the environment and human life is threatening by the pollutions resulted from energy generation used by steam and gas turbines(2). For this reason the researchers attracted to develop renewable energy and explore its large benefits and unit capacity.

Wind power is one of the clean renewable energy resources; therefore it is importantto study the opportunity of implementing this resource inKuwait state as Middle East country with a special climate, draw our attention to make this research emphasis on the technical and economic aspects, and study the suitability of environmental conditions. Whereas, in some areas of the world they implement some renewable energy even if it has some geographical and electrical obstacles or restrictions like power fluctuating for land wind generationsuch as in Japan. And the introduction of large amount of wind power generation tends to be extremely difficult and even impossible in is some location. This research is aimed to concentrate on the visibility of utilizing the wind energy as complementary source for the existing steam and gas turbine power stations in Kuwait, besidesexplain the economical perspectives that will guide us to take the right decision.

The locationof the wind farms is very important in this aspect to obtain the maximum wind power to construct such projects, away from the cities,inhabitants and buildings, andalso meeting the minimum requirements for economic generation.

II. Literature Review

In this paper, the existing case of power generation and fairs is explained for the case of Kuwait, the necessity of applying sustainable energy is clarified and the outcome from utilizing the wind turbine on the society and economy is satisfied, presenting different cases form some countries are supported our results andviewing the advantagesof using wind turbine from other countries which already has long experience in this field, beside that studying the weather in Kuwait for a period of one year daily.

2.1 Kuwait Electricity Background

Kuwait's Ministry of Electricity and Water is the sole authority that manages the generation/production, transmission and distribution of electricity and water in Kuwait. The authority heavily subsidizes the cost to the end consumer for these utilities, and consequently, these subsidies are one of the more concerns of the government. The government's electricity and water subsidies are as high as 93% of the original cost of manufacturing, resulting in total subsidies of 2.6 billion KWD per year. The expected increase by 2030 as high as9 billionKWD. Kuwait uses almost 300,000 barrels of oil per day of electricity generation and expected to increase by 20% as high as 900000 barrels per day, thus putting a dent on oil revenues of the country. [8]
Kuwait has one of the highest per capita energy consumption in the world. According to global Footprint Network, an average Kuwaitiuses 22 times more resources than the country provides per person. Electricity in Kuwait charged at 2 fills per Kwh since 1966, which is a fraction of 38 files it cost to produced[02]. The highest energy consumption was at summer 2013.

Increasing in population numbers day by day motivate researchers to look forward on how to drive the energy generation towards the right path to ensure the availability of the energy in acceptable prices and to maintain the living standards and follow the world's developed nations. Moreover, the necessity of havingcleanenvironment without pollution. This can be done by utilizing the sustainable energy which reduces the dependence on oil and gas in producing electrical energy which considered the only source of energy in Kuwait.

2.2 The Renewable Energy

This paper discusses and offers some suggestions as pathways to a sustainable energy infrastructure, "sustainable in this context means capable of supplying a growing population with energy without destroying the environment" [7].Energy generation, environment and economics terms should be put under considerations while we think and plan seriously to have bright future for us and for new generation.
The paper perspective in submitting this issue includes the followings:

1- Advise to create a sustainable energy infrastructure bases for establishing the wind turbine farms.
2- Long terms benefits to society from utilizing advanced renewal energy systems, other than improvements in economics, environment and creating new job vacancies.
3- Advise to construct factories to manufacture wind turbine with cooperating with international companies to meet quality and standardization, and to cover the local market with the requirements of spare parts for the existing plants.

Depending on sequestration technology is giving our society high risk in fluctuating the use of this technology where all world trends to use the sustainable technology.
Diversity in energy generation by using sequestration technology and renewable technology will provide us with more stability in the power networks and give more confidence in using advanced technology applications.

From economical point of view, the reduction of prices by using the wind turbine will be much remarkable and will remove some of the customer life burdens if the actual cost of generated energy is considered for the consumers. This can be measure by net energy can gain during life time where "Implementing an energy infrastructure that uses more energy in its manufacturing and deployment that it produces it's lifetime is not a viable pathway for future"[7].

The payback time for wind turbine is faster than Photo Voltaic system,WherePV systems payback needs three to four years for life time of 30 years to give ratio from 8 to 10 times comparing with wind turbine which needs to two to three months of 20 years life time and including the scraping the turbine at the end of life time to give impressive ratio equal to 80 time. The Wind, Water, and Sun (WWS) electricity system offers new challenges but also new opportunities with respect to reliably meeting energy demands. On the positive side WWS technologygenerally suffer less down-time than do current electric power technologies. For example the average coal plant in the US FROM 2000 to 2004 was down 6.5% of the year for unscheduled maintenance and 6% of the year or scheduled maintenance.(North American Electric Reliability Corporation,2009a), but modern wind turbines have a down time of only 0-2% over landand 0-5% over the ocean (Dong Energy et al). Moreover, there is an important different between outages of centralized power plant (coal, nuclear, and natural gas) and outages of distributed plants (wind, solar, and water): when individual wind turbines or solar are down, only a small fraction of electrical production is affected, whereas when one or more a centralized plant is offline at the same time, the entire grid can be affected [9].

The International Renewable Energy Agency (IRENA) is an intergovernmental organization that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a center of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy.IRENA states in their working paper of Smart Grids and Renewables "Electricity generation from renewable sources will need to increase significantly to achieve the Sustainable Energy objective of doubling the share of renewable energy in the global energy mix by 2030". And clearly explain that "Fortunately, there is growing evidence in many countries that high levels of renewable energy penetration in the grid are technically and economically feasible, particularly as solar and wind technologies increasingly reach grid parity in economic terms"[10].

However, the starting of implementation of renewable energy in Kuwait and the expandgrowth of the share of renewables in centralized grid requires an effective new approach to grid management, making full use of "smart grids" and "smart grid technologies". Existing grid systems already includeelements to function in away to balance supply and demand. Where the smart grids combine information and communications technology into every aspect of electricity generation, delivery and consumption in order to minimize environmental impact, enhances markets, improve reliability and service, and reduce costs and improve efficiency and managing the renewables supply efficiently. Case studies from Denmark, Jamaica, the Netherlands, Singapore, and the United States (New Mexico and Puerto Rico) are featured in this report to highlight successful combinations of smart grid technologies with renewable energy integration, consequently and to be more specific Denmark has long used several smart grid technologies to support the world's highest wind penetration. With around 30% of its electricity coming from wind the International Renewable Energy Agency (IRENA) launched a global renewable energy roadmap for doubling the share of renewables in the global energy mix by 2030. Furthermore The International Energy Agency's (IEA) "sustainablefuture" scenario shows renewables providing57% of world electricity by 2050 (IEA,2012, p. 10) [10]

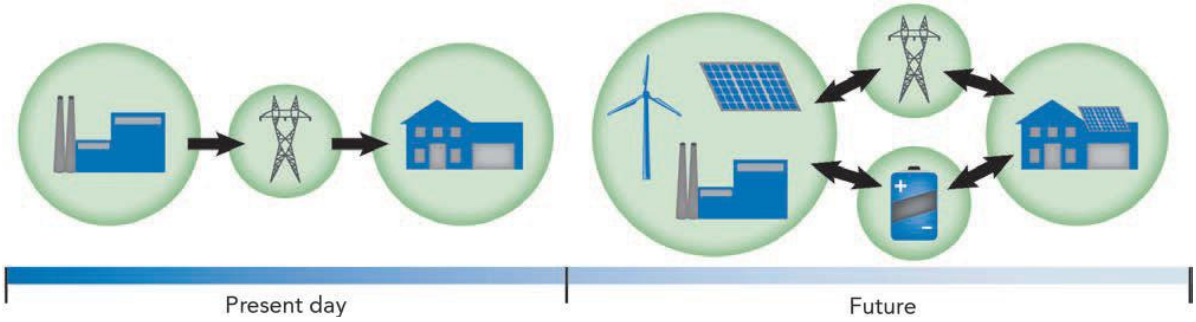


Fig.1: TraditionalGrid vs. Smart Grid[10]

III. The Methodology

An economical wind power generation of large scale farms developed very fast, at the same time different obstacles is facing us to build up these generators;a geographical obstacle is one of the important factors which depend on the nature of the land and the wind speed [2].However the land nature in Kuwait is desert and almost flat. Related to some studies were done in USA found the wind speed range between 12.5-24.9 mph at 50m height which correspond to power capacity 200-600 W/m^2. As a general rule, economic wind generators require wind speed of 10 mph (16 km/h) or greater [3].

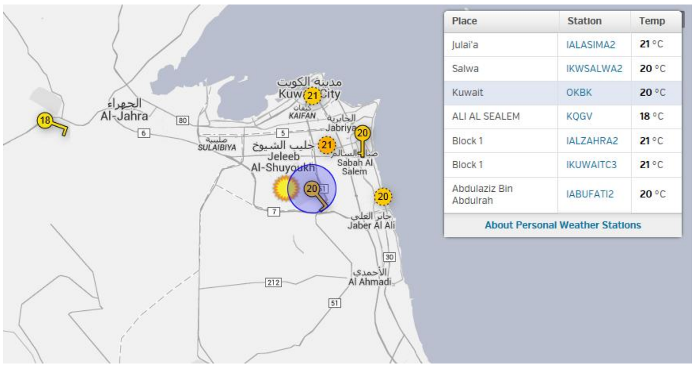


Fig.2:Kuwait wind Speed measurements
Source:Kuwait Airport [5]

A large wind farm may consist of several hundred individual wind turbines, and cover an extended area of hundreds of square miles, but the land between the turbines may be used for agricultural or other purposes. A wind farm may be located offshore to take advantage of strong winds blowing over the surface of an ocean or lake and the November
2010[update],the Thanet Offshore Wind Project in United Kingdom is the largest offshore wind farm in the world at 300 MW [3].

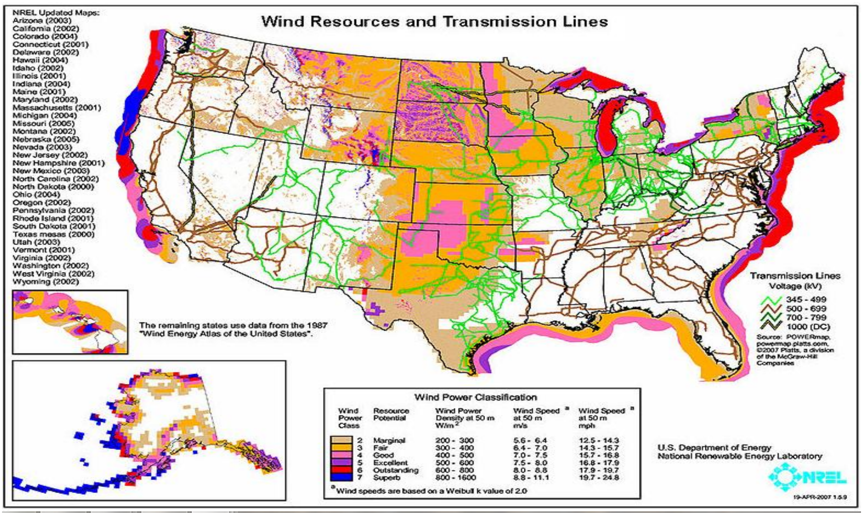


Fig.3: Wind Power Classification in U.S. [3]

The second obstacle is wind power generation in particular, that its output cannot be fully controlled in accordance with daily demand curves and the output fluctuations of the wind power caused by wind gusts remain. Furthermore, the fluctuations of both power andvoltage due to frequent changes of wind velocity and direction result in low availability and economic issues in Japan [4].

However, up to now just limited information you can get from the historical weather data around Kuwait areas.For this purpose, we try to make a basic research by taking considerationof the following aspects:
(1) Selection of the best location (historical data available) suitable for introducing the area around Kuwait airport to wind power generation.
(2) Identification of the difference of wind and power output between monthly.
(3) Expected power generation from this farm.
(4) Basic design of the circuits and control system.
(5) Verification of the basic operation and behaviors of the designed system.

IV. Discussions

4.1 Experiments and Technical works

The study is interested to evaluate the renewal energy using wind turbine in Kuwait state, one location was chosen as a model from the 7 places shown on Kuwait weather map.

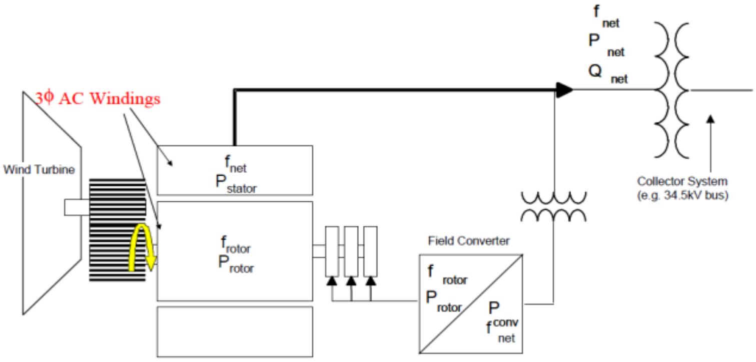


Fig.4: G.E. WTG major Components

Kuwait airport has an open area and consequently will have a better image of renewal power generation in Kuwait. the historical data was gathered from the seasonal weather average station [5] with the charts for the wind speed and direction accordingly the power generated capacity can becalculated per m^2, A selection of one day per month (total 12 days) for the year of 2011 as a sample. See table no.1 "Wind speed measurements in Km/h at Kuwait international airport".

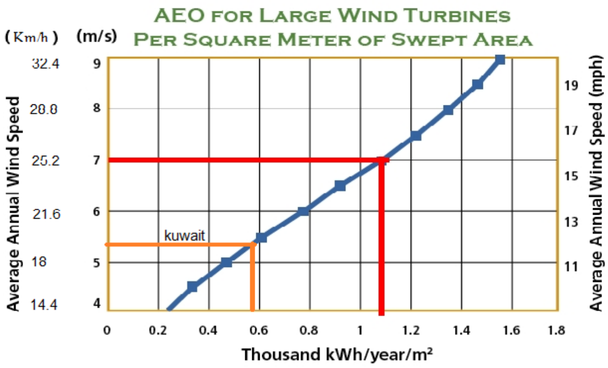


Fig.5: Annual Energy Output for Large Wind Turbines

The data were manipulated to come up with results of the maximum, minimum and average wind speed as shown in table 2. At higher altitudes the wind blows faster because of the reduced influence of drag. The increase in velocity with altitude is most dramatic near the surface and is affected by topography, surface roughness, and upwind obstacles such as trees or buildings.

Typically, the increase of wind speeds with increasing height follows a wind profile power law, which predicts that wind speed rises proportionally to the seventh root of altitude. Doubling the altitude of a turbine, then, increases the expected wind speeds by 10% and the expected power by 34% [3].

Individual turbines are interconnected with a medium voltage (usually 34.5 kV) power collection system and communications network. At a substation, this medium- voltages electrical current is increased in voltage with a transformer for connection to the high voltage transmission system. Construction of a land-based wind farm requires installation of the collector system and substation [3].

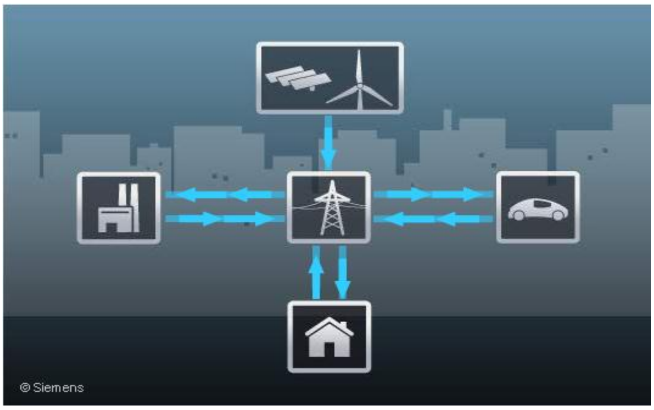


Fig.6: the collector system and substation
Source:

The world's first wind farm – consisting of 20 wind turbines rated at 30 kilowatts each. It has been observed that wind farm performance is improving, mainly in respect of equipment design, permitting more efficient conversion, and in respect of reliability with reduced downtime of individual turbines within farms;a rated capacity of a wind turbine of this size at 25-35 kW [3].

Measure of wind turbine performance is necessary in design stage, where there are several measures of wind turbine productivity in common use, some more meaningful than others: generation per turbine (kWh/unit), generation per unit of capacity (kWh/kW), capacity factor (%), and specific yield or generation per unit of area swept by the turbine's rotor (kWh/m²) where the capacity factor can calculated, for example, Suppose you have a generator with a power rating of 1000 kW. Hypothetically if it ran at full power for 24 hours a day for 365 days, that would be:
(1000 kW) x (365 x 24 hours) = 8,760,000 kW-hr in one year. Suppose that in fact it made 2,920,000 kWh in one year. Then in that year, the generator operated at a: 2,920,000 / 13,140,000 = 30% capacity factor that year,for more details [6].

Typical Specific Yields for Commercial Wind Turbines Annual generation per turbine or Annual Energy Output (AEO) is used by developers, investors, farmers, and homeowners to gauge performance because it is easily understood and directly comparable to performance projections.

V. Results of Discussion

Based on the historical data gathered from the site of weather station at Kuwait airport as illustrated in table No.1, selection of one day per month (randomly) where data variables were recorded every half an hour in appendix and resulted calculations as illustrated in table No.2. It is to be noticed that it was found some abnormality of very high speed of wind and this wasexcluded from study such as data recorded (161 Km/h at Apr 9, 2011) the same chart was included in appendix.

As mentioned in introduction that " economic wind generators require wind speed of 10 mph (16 km/h) or greater" and the average results of wind speed calculated 18.5 Km/h which is consider over the minimum requirements of the economical generation which is equal to Annual generation per turbine or Annual Energy Output 0.6 KWh/year/m^2.

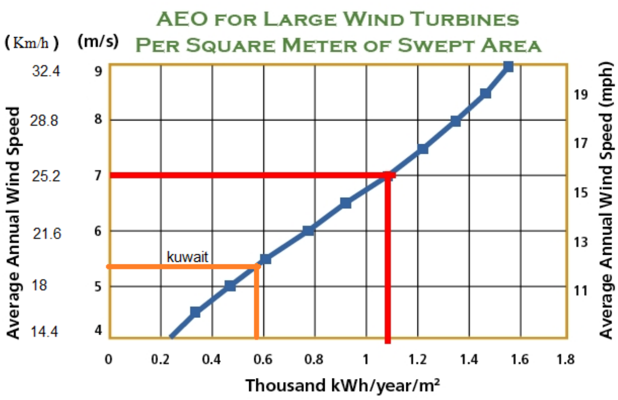
Table 2: Summary of the wind speed study

months	Max. Speed (Km/h)	Min. Speed (Km/h)	Average speed (Km/h)
Jan 2011	27.8	7.4	19.4
Feb 2011	25.9	5.6	14.9
Mar 2011	16.7	5.6	10.9
Apr 2011	59.3	5.6	31.3
May 2011	25.9	0	12.5
Jun 2011	6.7	0	8.4
Jul 2011	40.7	5.6	23.2
Aug 2011	44.4	18.5	30.0
Sep 2011	25.9	7.4	17.9
Oct 2011	29.6	5.6	19.5
Nov 2011	31.5	7.4	21.0
Dec 2011	27.8	0	13.4
Resultant	**59.3**	**0**	**18.5**

Smart grid technologies are already making significant contributions to electricity grid operation in several countries, therefore it is recommended to upgrade the electrical grid to Smart Grid before initializing the implementation of large scale Wind turbine farms, and start by small farm for the case of economic benefits for the supplier and consumers.

VI. Conclusion

As a result of the study which indicate that the power generated by the wind turbine is above the accepted economical generated which measured by Annual Energy Output (AEO) for large Wind Turbines per Square Meter of Swept Area,and it is advisable to build wind farms in that area and also build farms in desert or offshore areas where the wind speed might be better and as much wind turbine we put as much free energy we get. And it is suggested to get benefits from the wind generated by plane while taking off.



Where further studies have to be accompanied using wind turbine must follow that, such as Storage of energy, Distribution, and Smart Grids to complete a power system of connecting energy storage systems keep in mind the weather situation in Kuwait.

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Appendix

Table no.1 "Wind speed measurements in Km/h at Kuwait international airport"
Abnormal maximum wind speed recorded in April 9, 2011 was 161 Km/h
Charts of weather parameters recorded for the selected days of the year 2011

A. Table1: Wind speed measurements in Km/h at Kuwait international airport

	Wind speed Km/h											
Time (AST)	Jan 1-2011	Feb-1-2011	Mar-5-2011	April 4-2011	May-6-2011	Jun-7-2011	Jul-10-2011	Aug-5-2011	Sep-2-2011	Oct-10-2011	Nov-2-2011	Dec-2-2011
12:00 AM	20.40	18.50	9.30	42.60	5.60	11.10	38.90	22.2	14.8	18.5	16.7	7.4
12:30 AM	18.50	22.20	7.40	37.00	11.10	5.60	40.70	18.5	7.4	18.5	18.5	0
1:00 AM	22.20	22.20	9.30	40.70	5.60	0.00	38.90	25.9	9.3	14.8	16.7	5.6
1:30 AM	20.40	24.10	13.00	38.90	7.40	0.00	38.90	25.9	24.1	16.7	22.2	0
2:00 AM	20.40	20.40	13.00	33.30	9.30	7.40	31.50	22.2	22.2	16.7	18.5	0
2:30 AM	18.50	20.40	11.10	33.30	9.30	9.30	31.50	20.4	22.2	16.7	22.2	0
3:00 AM	18.50	24.10	9.30	33.30	11.10	7.40	31.50	22.2	18.5	18.5	16.7	7.4
3:00 AM	18.50	24.10	9.30	33.30	11.10	7.40	31.50	22.2	18.5	18.5	16.7	7.4
3:30 AM	20.40	20.40	11.10	31.50	7.40	5.60	33.30	24.1	25.9	13	22.2	7.4
4:00 AM	20.40	16.70	9.30	29.60	9.30	5.60	31.50	25.9	20.4	16.7	25.9	11.1
4:30 AM	14.80	11.10	7.40	27.80	11.10	5.60	35.20	22.2	18.5	16.7	22.2	
5:00 AM	18.50	9.30	11.10	27.80	9.30	11.10	31.50	20.4	14.8	14.8	22.2	5.6
5:30 AM	16.70	13.00	5.60	16.70	7.40	7.40	31.50	22.2	14.8	13	22.2	
6:00 AM	18.50	13.00	5.60	20.40	5.60	7.40	27.80	20.4	16.7	9.3	20.4	11.1
6:30 AM	20.40	13.00	5.60	22.20	0.00	0.00	31.50	24.1	14.8	5.6	24.1	11.1
7:00 AM	24.10	16.70	9.30	18.50	0.00	9.30	31.50	22.2	13	11.1	24.1	
7:30 AM	20.40	16.70	7.40	24.10	3.70	7.40	27.80	27.8	18.5	14.8	25.9	13
8:00 AM	20.40	14.80	7.40	27.80	5.60	14.80	25.90	22.2	20.4	14.8	24.1	11.1
8:30 AM	20.40	13.00	5.60	31.50	5.60	11.10	25.90	25.9	22.2	18.5	27.8	9.3
9:00 AM	22.20	11.10	7.40	35.20	5.60	11.10	31.50	27.8	22.2	22.2	27.8	9.3
9:00 AM	22.20	11.10	7.40	35.20	5.60	11.10	31.50	27.8	22.2	24.1	25.9	9.3
9:30 AM	22.20	7.40	5.60	40.70	9.30	11.10	31.50	29.6	22.2	25.9	29.6	9.3
10:00 AM	25.90	14.80	11.10	38.90	7.40	13.00	33.30	37	25.9	27.8	27.8	13
10:30 AM	22.20	13.00	13.00	33.30	9.30	11.10	31.50	33.3	24.1	29.6	31.5	16.7
11:00 AM	22.20	18.50	11.10	35.20	0.00	5.60	27.80	38.9	24.1	27.8	29.6	22.2
11:30 AM	22.20	16.70	11.10	37.00	9.30	11.10	27.80	40.7	22.2	27.8	29.6	20.4
12:00 PM	24.10	14.80	11.10	40.70	13.00	5.60	25.90	42.6	20.4	29.6	31.5	22.2
12:30 PM	22.20	14.80	11.10	57.40	16.70	11.10	27.80	38.9	18.5	29.6	22.2	22.2
1:00 PM	24.10	18.50	16.70	59.30	18.50	7.40	11.10	38.9	16.7	27.8	29.6	22.2
1:30 PM	25.90	20.40	14.80	55.60	22.20	14.80	9.30	44.4	18.5	27.8	27.8	24.1
2:00 PM	24.10	18.50	14.80	53.70	25.90	9.30	22.20	38.9	16.7	22.2	27.8	24.1
2:30 PM	25.90	18.50	14.80	57.40	22.20	11.10	16.70	37	18.5	29.6	25.9	27.8
3:00 PM	27.80	20.40	16.70	57.40	22.20	11.10	16.70	38.9	20.4	25.9	22.2	22.2
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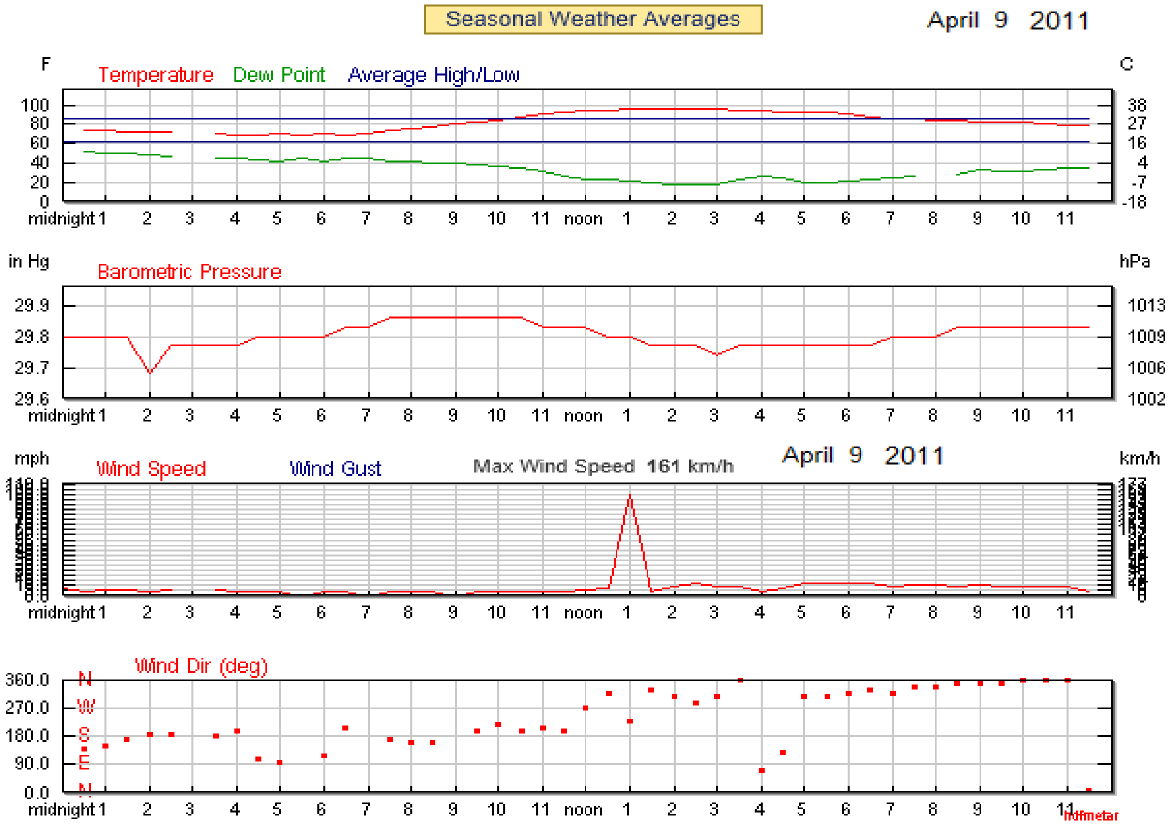
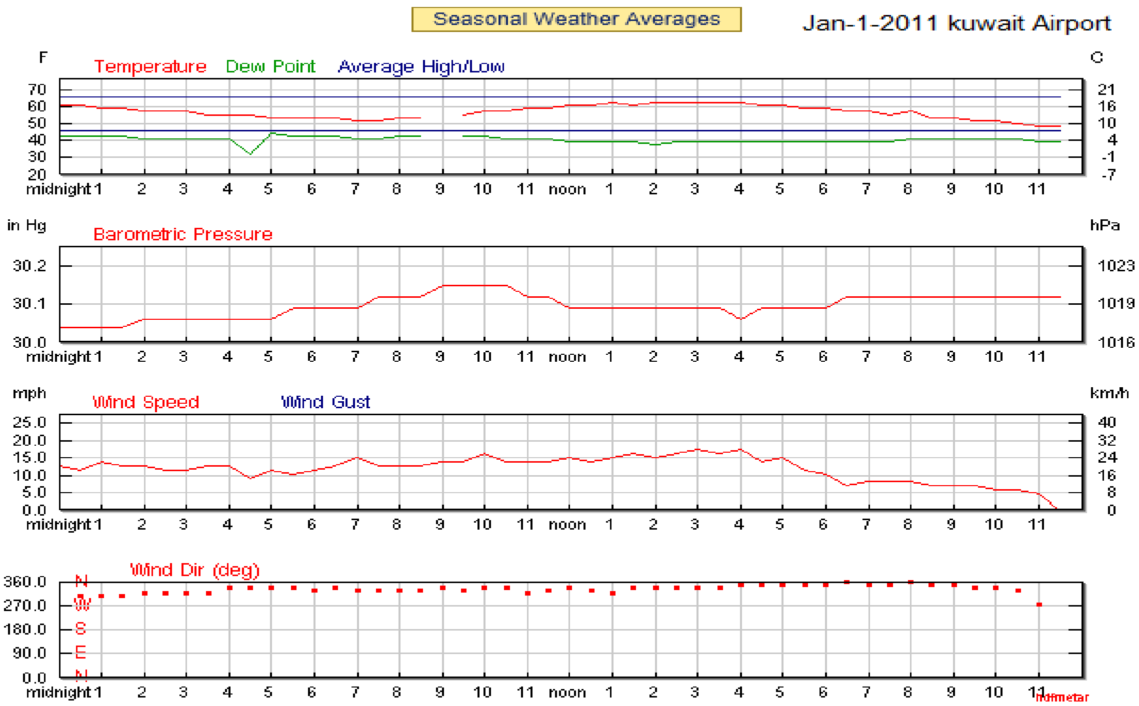
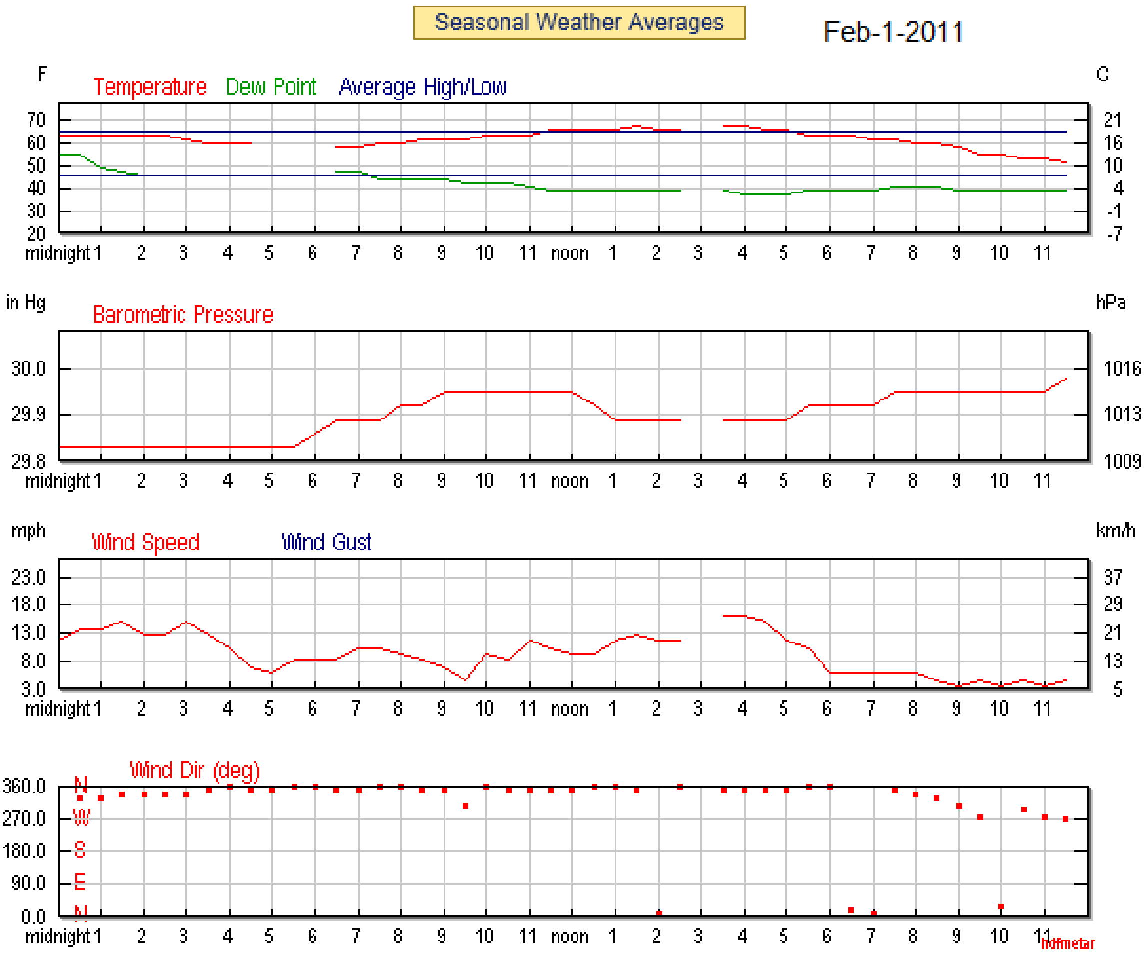
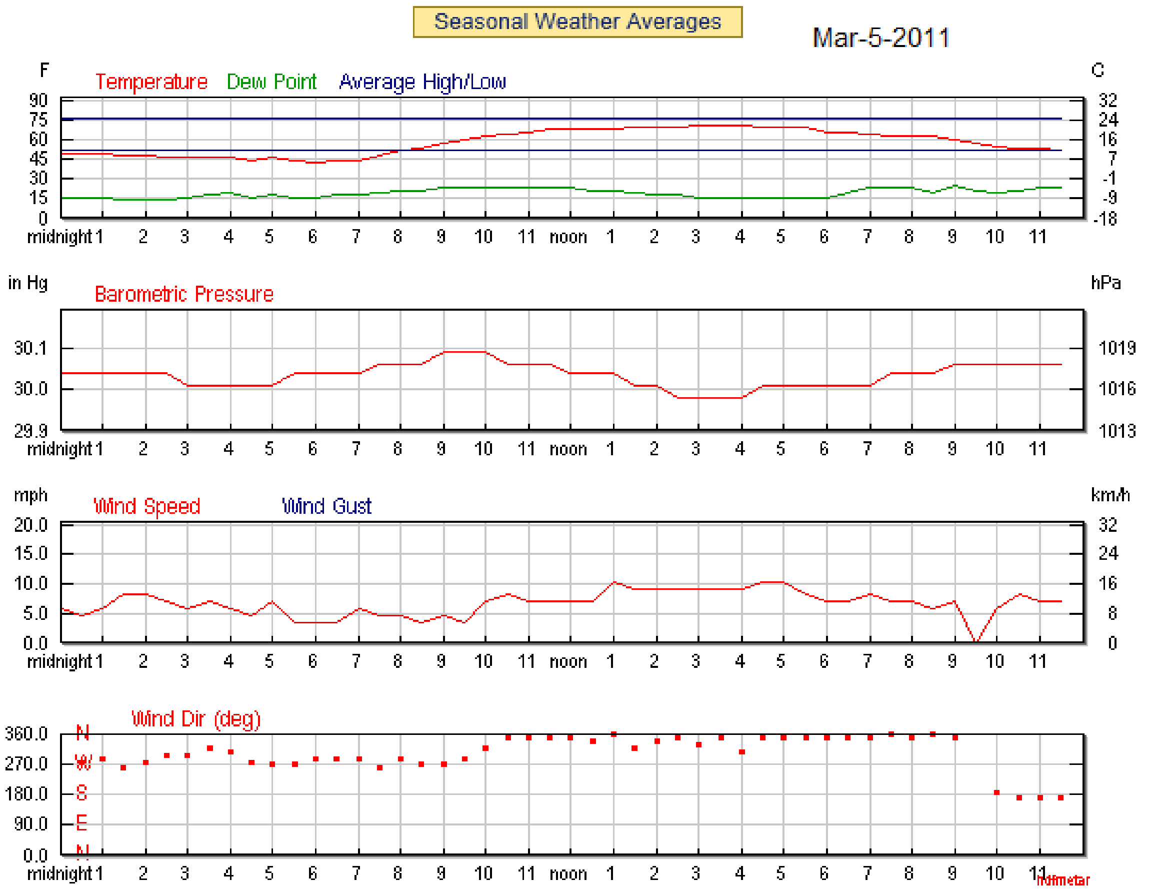
5:00 PM	24.10	18.50	16.70	37.00	24.10	16.70	16.70	38.9	18.5	18.5	18.5	16.7
5:30 PM	18.50	16.70	13.00	18.50	22.20	14.80	13.00	33.3	18.5	14.8	18.5	11.1
6:00 PM	16.70	9.30	11.10	5.60	22.20	13.00	16.70	37	11.1	14.8	18.5	9.3
6:30 PM	11.10	9.30	11.10	9.30	22.20	11.10	14.80	31.5	18.5	14.8	-	14.8
7:00 PM	13.00	9.30	13.00	9.30	14.80	7.40	14.80	31.5	18.5	16.7	13	14.8
7:30 PM	13.00	9.30	11.10	20.40	9.30	5.60	9.30	29.6	16.7	14.8	11.1	11.1
8:00 PM	13.00	9.30	11.10	18.50	11.10	0.00	9.30	25.9	16.7	14.8	11.1	14.8
8:30 PM	11.10	7.40	9.30	16.70	13.00	11.10	11.10	25.9	13	13	11.1	16.7
9:00 PM	11.10	5.60	11.10	16.70	13.00	0.00	11.10	27.8	13	13	9.3	13
9:00 PM	11.10	5.60	11.10	16.70	13.00	0.00	11.10	27.8	13	18.5	7.4	13
9:30 PM	11.10	7.40		14.80	9.30	5.60	13.00	27.8	11.1	25.9	9.3	13
10:00 PM	9.30	5.60	9.30	18.50	13.00	7.40	11.10	24.1	14.8	24.1	9.3	13
10:30 PM	9.30	7.40	13.00	5.60	5.60	0.00	11.10	31.5	9.3	9.3	9.3	9.3
11:00 PM	7.40	5.60	11.10	7.40	14.80	5.60	5.60	35.2	16.7	16.7	16.7	11.1
11:30 PM		7.40	11.10	18.50	20.40	5.60	13.00	33.3	14.8	14.8	14.8	13
Max	27.8	25.9	16.7	59.3	25.9	16.7	40.7	44.4	25.9	29.6	31.5	27.8
min	7.4	5.6	5.6	5.6	0	0	5.6	18.5	7.4	5.6	7.4	0
average	19.39411765	14.9372549	10.94117647	31.34038462	12.47692308	8.376923077	23.22884615	30.01730769	17.91538462	19.48076923	20.95294118	13.35306122

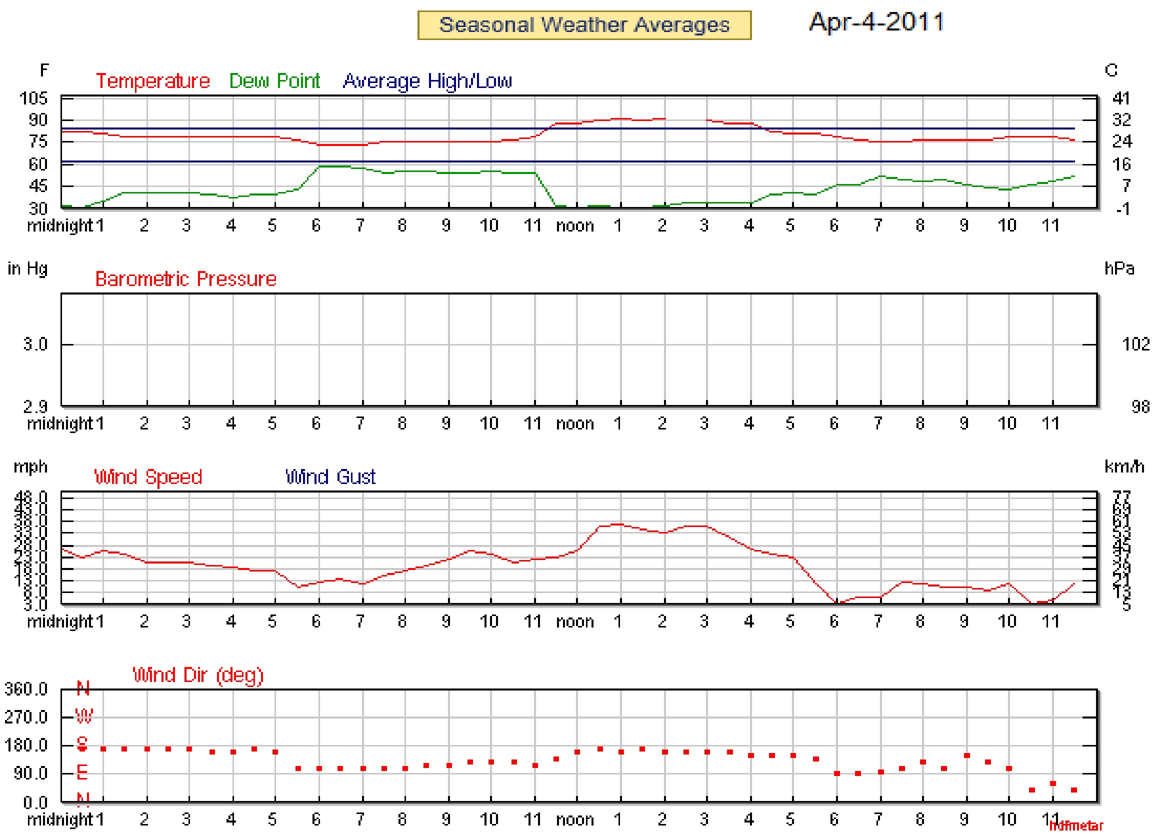
B. Charts of weather parameters recorded for the selected days of the year 2011

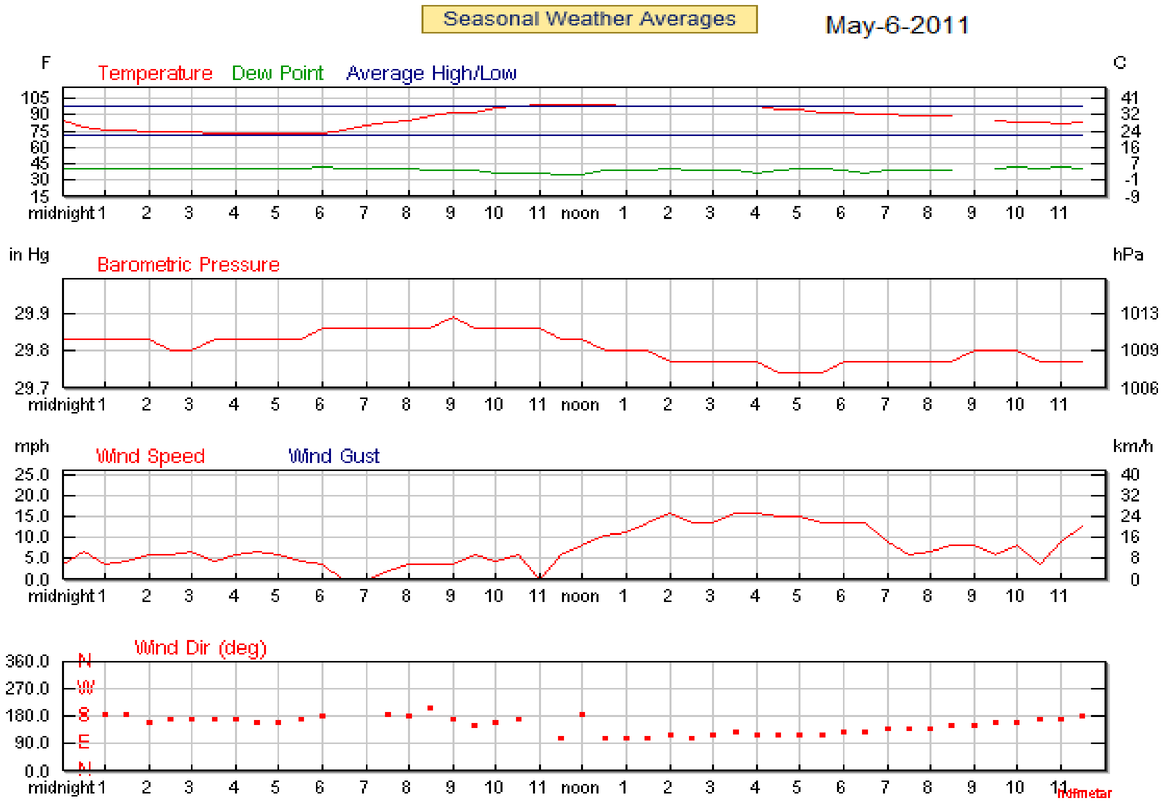


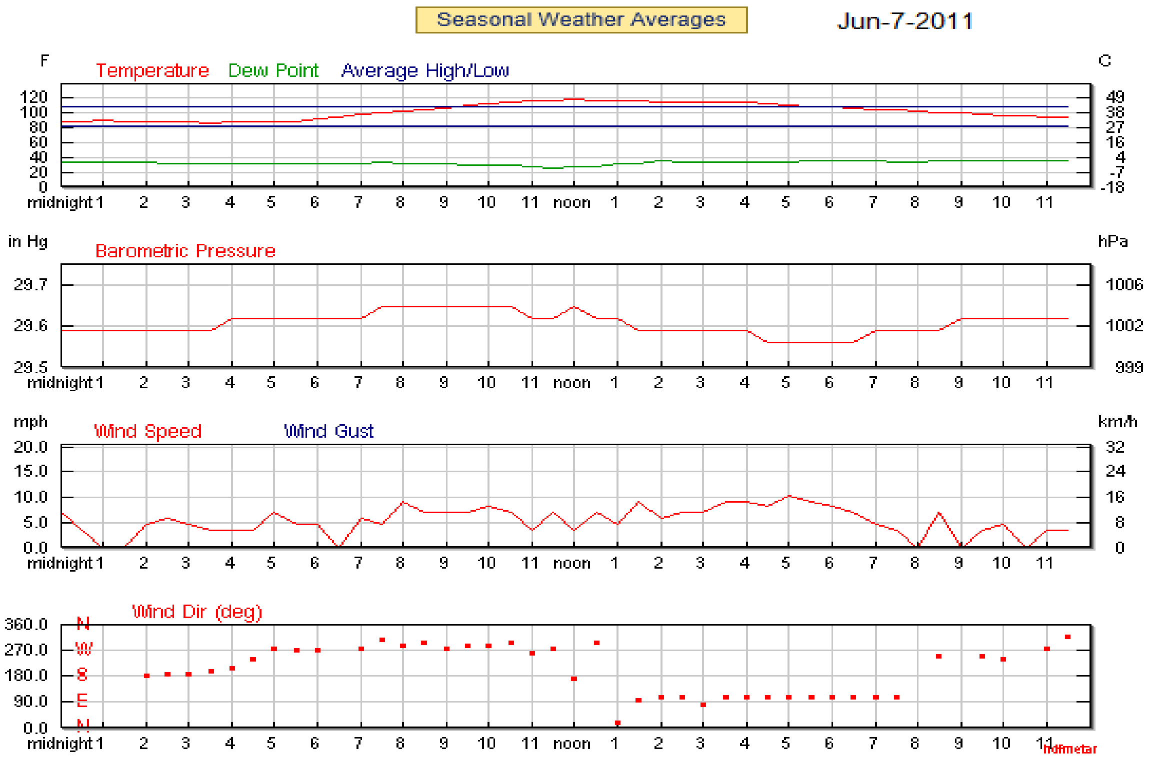


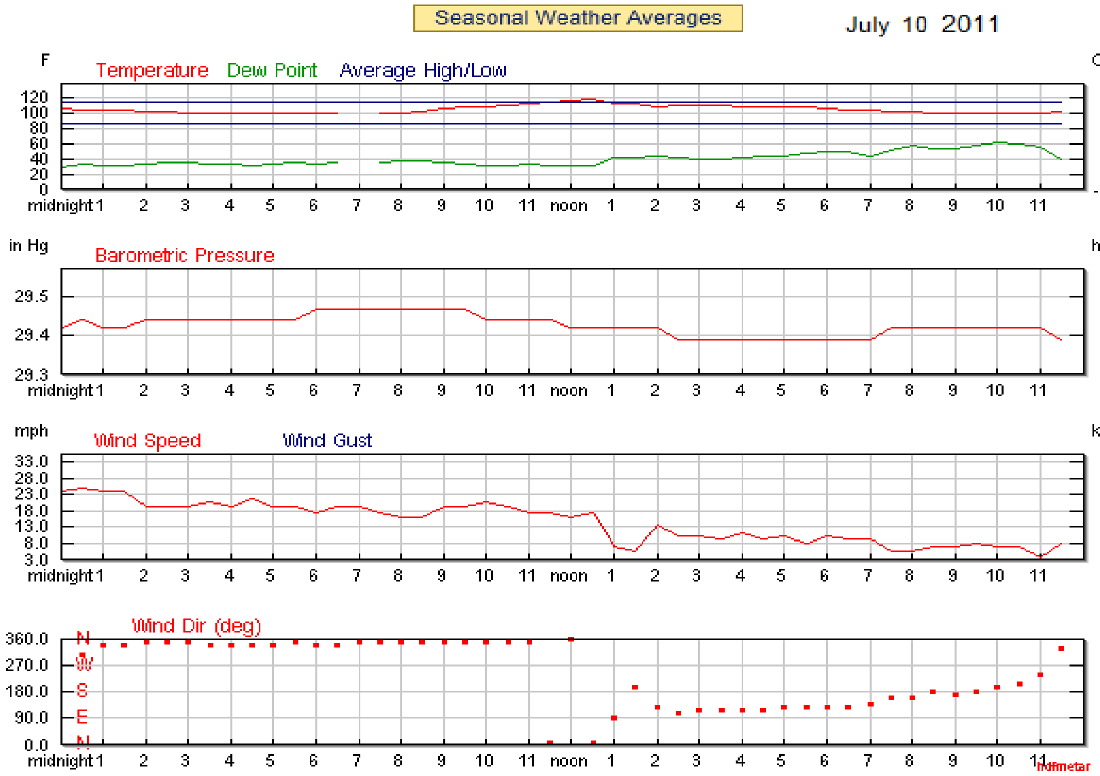

Seasonal Weather Averages
Feb-1-2011
F
Temperature
Dew Point
Average High/Low
C
70
60
50
40
30
20
21
16
10
4
-1
-7
midnight 1 2 3 4 5 6 7 8 9 10 11 noon 1 2 3 4 5 6 7 8 9 10 11
in Hg
Barometric Pressure
hPa
30.0
29.9
29.8
1016
1013
1009
midnight 1 2 3 4 5 6 7 8 9 10 11 noon 1 2 3 4 5 6 7 8 9 10 11
mph
Wind Speed
Wind Gust
km/h
23.0
18.0
13.0
8.0
3.0
37
29
21
13
5
midnight 1 2 3 4 5 6 7 8 9 10 11 noon 1 2 3 4 5 6 7 8 9 10 11
Wind Dir (deg)
360.0
270.0
180.0
90.0
0.0
N
W
S
E
N
midnight 1 2 3 4 5 6 7 8 9 10 11 noon 1 2 3 4 5 6 7 8 9 10 11
Wunderground / hdmetar

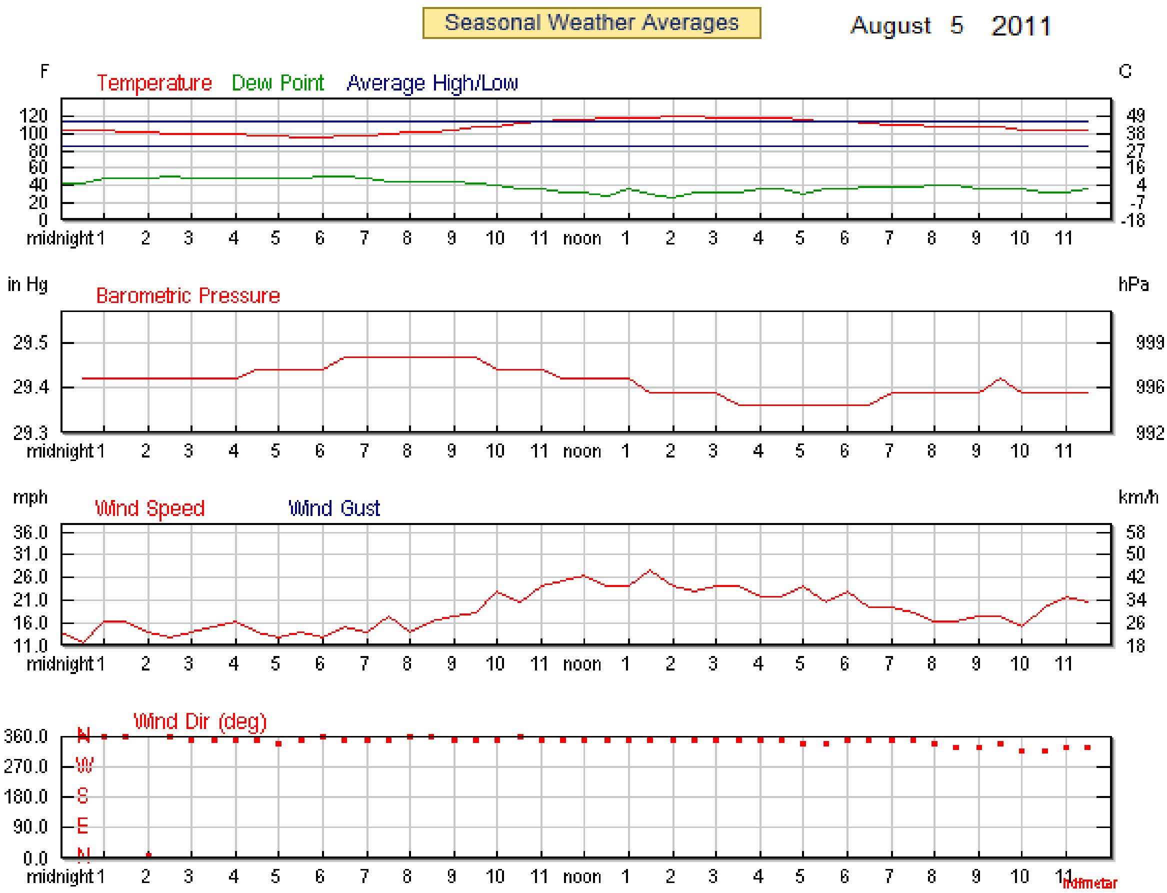

Seasonal Weather Averages
Mar-5-2011
F
C
Temperature
Dew Point
Average High/Low
midnight 1 2 3 4 5 6 7 8 9 10 11 noon 1 2 3 4 5 6 7 8 9 10 11
in Hg
hPa
Barometric Pressure
mph
km/h
Wind Speed
Wind Gust
Wind Dir (deg)
N
W
S
E
N
wdmetar

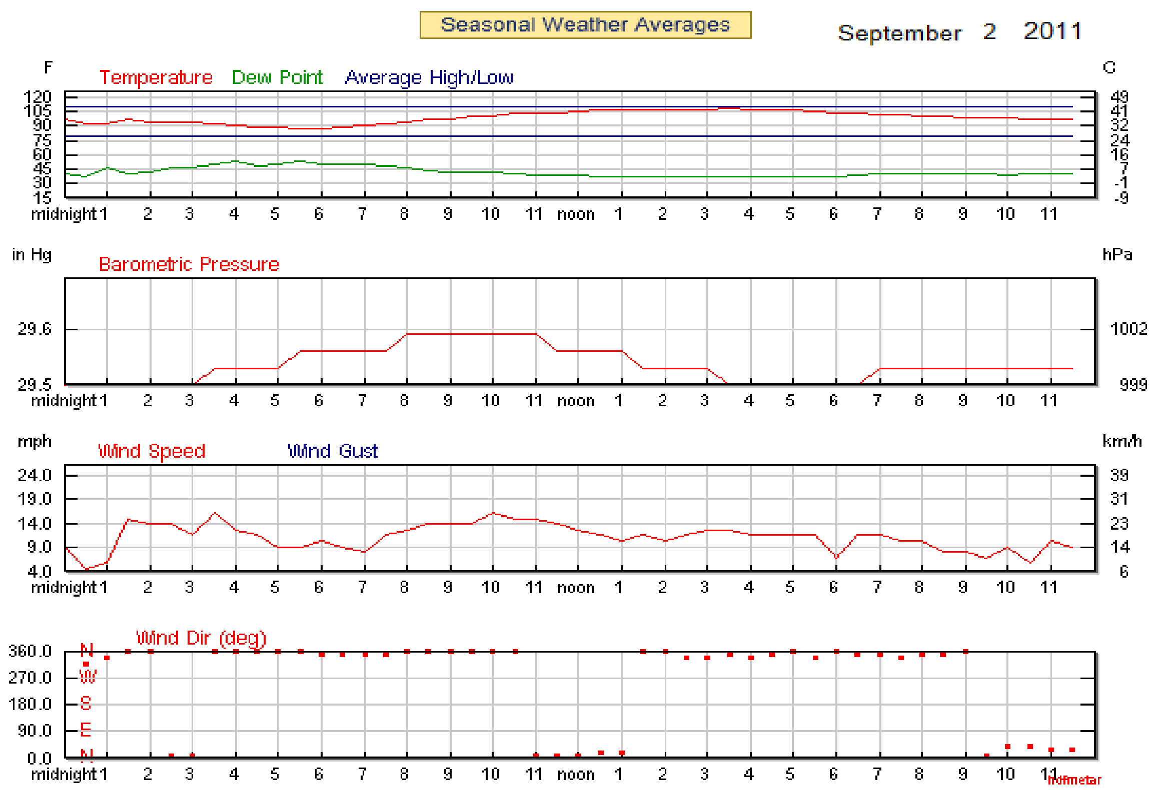

Seasonal Weather Averages
Apr-4-2011
F
C
Temperature
Dew Point
Average High/Low
midnight 1 2 3 4 5 6 7 8 9 10 11 noon 1 2 3 4 5 6 7 8 9 10 11
in Hg
hPa
Barometric Pressure
mph
km/h
Wind Speed
Wind Gust
Wind Dir (deg)
N
W
S
E
N
wdmetar

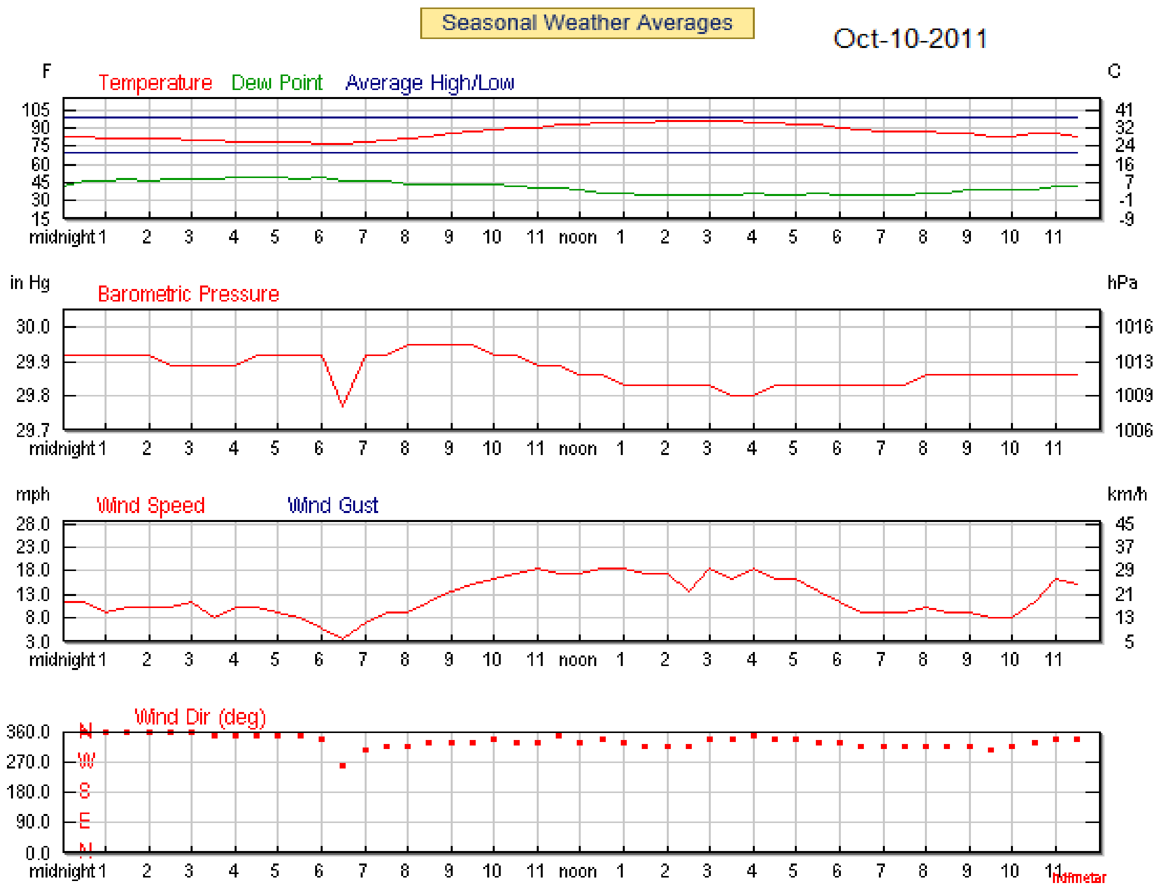

Seasonal Weather Averages
May-6-2011
Temperature Dew Point Average High/Low
Barometric Pressure
Wind Speed Wind Gust
Wind Dir (deg)

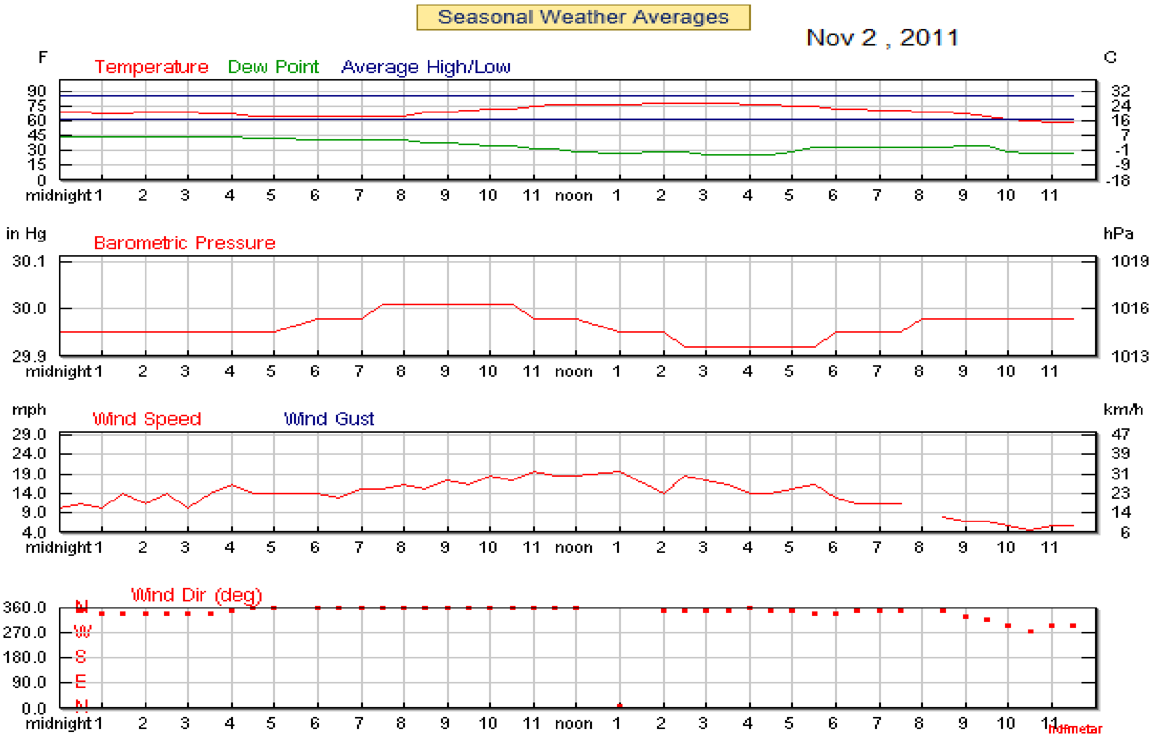

Seasonal Weather Averages
Jun-7-2011
Temperature Dew Point Average High/Low
Barometric Pressure
Wind Speed Wind Gust
Wind Dir (deg)

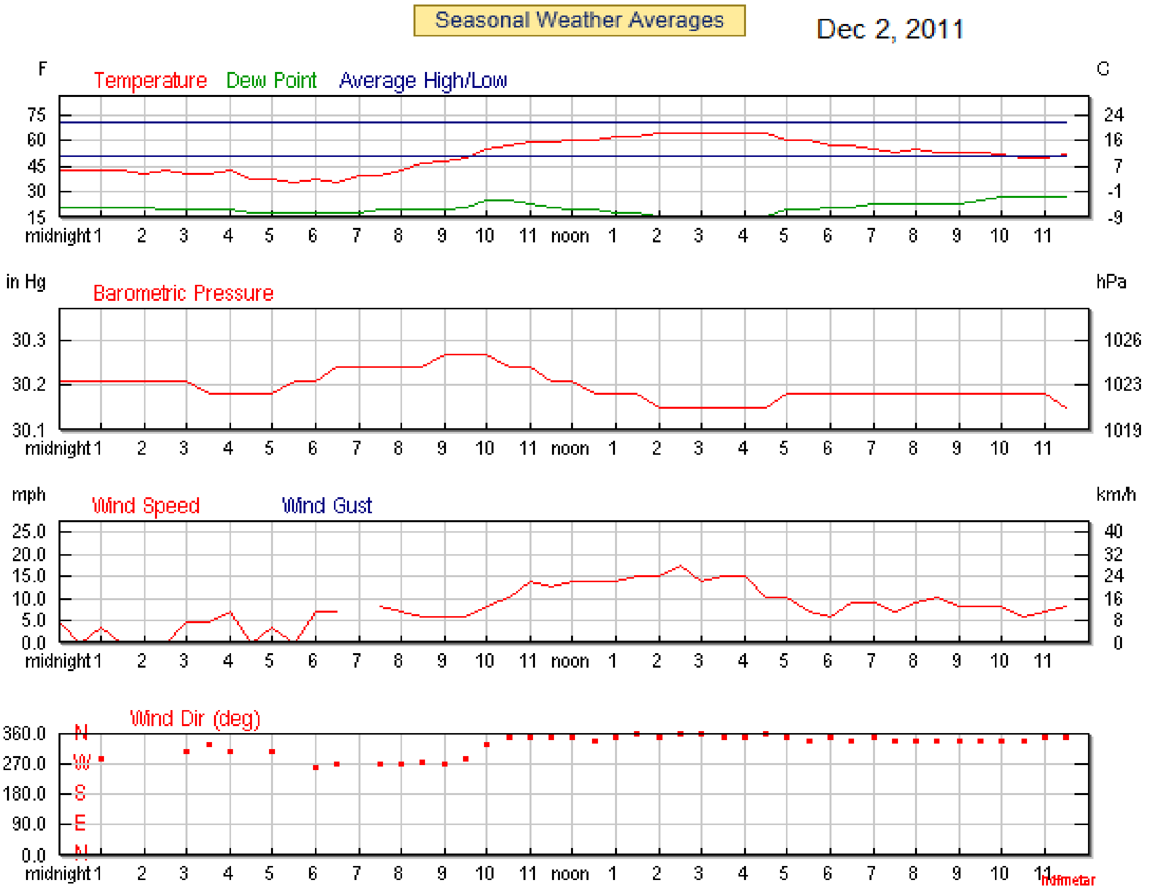

Seasonal Weather Averages
July 10 2011
F
Temperature
Dew Point
Average High/Low
C
Barometric Pressure
in Hg
hPa
Wind Speed
Wind Gust
mph
km/h
Wind Dir (deg)
midnight
noon
N
W
S
E
N
wdmetar


Seasonal Weather Averages
August 5 2011
F
Temperature
Dew Point
Average High/Low
C
Barometric Pressure
in Hg
hPa
Wind Speed
Wind Gust
mph
km/h
Wind Dir (deg)
midnight
noon
N
W
S
E
N
wdmetar


Seasonal Weather Averages
September 2 2011
Temperature
Dew Point
Average High/Low
Barometric Pressure
Wind Speed
Wind Gust
Wind Dir (deg)


Seasonal Weather Averages
Oct-10-2011
Temperature
Dew Point
Average High/Low
Barometric Pressure
Wind Speed
Wind Gust
Wind Dir (deg)


Seasonal Weather Averages
Nov 2 , 2011
Temperature
Dew Point
Average High/Low
Barometric Pressure
Wind Speed
Wind Gust
Wind Dir (deg)


Seasonal Weather Averages
Dec 2, 2011
Temperature
Dew Point
Average High/Low
Barometric Pressure
Wind Speed
Wind Gust
Wind Dir (deg)