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SUSTAINABLE DEVELOPMENT AND RENEWABLE ENERGIES AND THEIR APPLICATION IN SOME MODERN RESIDENTIAL COMPLEXES

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Abstract

An investigation, study was carried out on 6 residential compounds in Baghdad (Basmaya, Al-Zuhoor, Iraq Gate, Jawaher Dijla, Al-Ayadi Complex, and Al Yamamah city compound), four of them were located within the city center, while the other located outside, The aim of this study was to evaluate the specification of sustainable development or the use of renewable energy in these compounds with special consideration to the solar energy. The study findings showed that five of them depending on the state in electricity and only one compound have an electricity power plant. Furthermore, only one compound containing waste water treatment plant as well as, the lack of using smart systems in the residential units especially, the kitchens and bathrooms.

***Keyword*:** residential compound, solar energy, Sustainable development

Introduction

The resources donated by nature have often had a huge impact on the durability of life on earth, but the misuse of those resources has led to their depletion, which was reflected in the concept of sustainability that has been widely used in the last two decades. Sustainability has several applications in different fields of science and one of its most important bases was the urban planning science, sustainable urban environment aim to achieving compatibility and harmony between human needs and the surrounding environment requirements through interconnected axes that include the efficient use and good employment of existing building materials that available in the environment, taking into account the constants and variables of geography, climate, socio-economic and technological breakthrough (Kamouna and Haidar Abdul Razzaq, 2007). The concept of sustainability has been widely used since the seventies of the last century as response to the climatic and environmental challenges facing the planet, the heavy dependence on fossil fuels and the increase in global energy demand one of the main contributors to many other environmental issues. Sustainable has been defined in many ways, but the most frequently quoted definition was ensuring that current generations meets the needs of the present without compromising the ability of future generations to meet their needs (Keith Jones and Derek Clements-Croome, 2014). This means the need to work in solidarity between generations when development plans are to be drawn up, because sustainability is aimed primarily at development, which means the well-being of present generations, opening the way for future development simultaneously and thus the ability of future generations to benefit from available resources as we do today (Keith and Derek, 2014). Therefore, sustainability means that it should be deal with the development in wide insight in terms of the time dimension, the gap and the affected population (Hazmi and Ahmed, 2013). waste reduction, and the restrictions on the available resources within permissible limits is not feasible solution, but also to optimize the utilization of available capacities (Kharfeh and Ahmed, 2006). The concept of sustainable development means research and implementation of radical plans that enable society to successfully balance it interactively with the natural system, biotic and abiotic by maintaining a certain level of recovery (Mansour and Sayed Mari, 2005) Sustainable development depends on three main elements: 1. Economic ,Social,and Environmental elements as continuous interactive integrative concept as shown Figure 1.

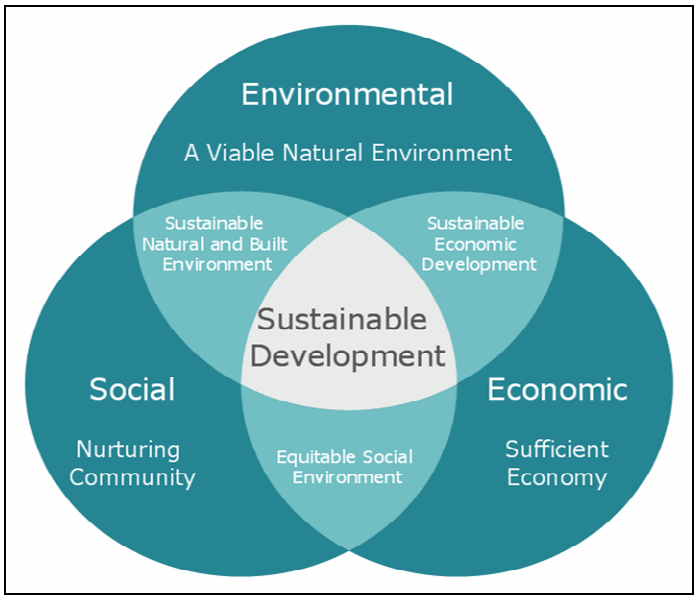

Fig. 1 : Illustrates the evolution of the interrelationship between elements of sustainability (Pintrest, 2018)

Finally, a comprehensive view during the preparation of sustainable development plans depending mainly on these three elements, taking into account the relative weight of each element and the principle of justice between generations

Sustainable Urban Environment and Renewable Energy

The environmental problem can consider as the most effective and dangerous to human life and health in urban cites that resulted from un-professional dealing of both urban planning and architectural design with the natural and climatic environment. In addition to, high level of

environmental pollution resulting from the heavy dependence of humans on fossil fuels in different spheres of life that has created an unhealthy environment, whether at the planning level public or at the level of private structural unit private. In order to understand a range of meanings, starting from understanding the meaning of the urban environment, which was the those elements are the same as those of the above-mentioned sustainable development and operate within the framework of a sustainable urban environment such the renewable energy. The concept of renewable energy reflects energy that was produced through natural processes and continuously regenerates, including sunlight, geothermal energy, wind, sea, water, and various forms of biomass energy which are naturally replenished. While the concept of alternative energy was any energy source that is an alternative to fossil fuel and often refers to non-conventional energy types that have little impact on nature. The Arab region, including Iraq characterized by an excessive wealth of renewable energy, as well as its oil and gas resources, It has the highest solar brightness on earth, moderate to high wind speeds and hydropower. However, there are multiple forms of renewable energy, such a solar power which is energy from the sun that is converted into thermal or electrical energy, which considered as the cleanest and most abundant renewable energy source available. The second type was Wind Energy that represent the most mature and developed renewable energy. It generates electricity through wind, by using the kinetic energy produced by the effect of air currents (James, 2009). Finally, Biomass energy or so-called biofuels are becoming increasingly common. Generating energy through burning, vaporizing, or fermenting biomass such as leftover plant material, vegetable waste, and manure are well-tried methods. A new shoot on this branch of energy production is the microbial fuel cell, which is capable of directly generating energy from substances such as waste water, Wave energy, oceans, and hot hydrogen fusion are other forms of renewable energy and are used to produce electricity, but cannot be adopted at this time to solve future energy problems. This research was focused on the solar energy, as Iraq have a huge solar energy and there are many ways to exploit it effectively, but this is still limited due to slow development of its technology. Solar energy can be classified into three categories. Thermal applications, Production of electricity, and Chemical operations. However, the most commonly used applications are water heating, and electricity generation which was currently increasing through photovoltaic (PV) systems and solar thermal technologies.

Concentrated solar energy technology

This technology was among the technologies that have enormous potential in reducing the cost of electricity production according to the International Renewable Energy Agency (James, 2009), because it has the potential to produce electricity even if the sun is absent. Where concentrated solar power plants are focused on solar radiation by mirrors that reflect the rays towards a special receiver unit that heats up to very high temperatures. That unit contains a heat transfer fluid whose function is to transfer heat to a steam generator that converts water into steam where it is at a very high temperature. The vapor is passed into the turbine) and the turbine is a mechanical device that extracts the thermal energy from the vapor pressure and converts it into a rotary movement) that will trigger the generator as is the case with the traditional power plants operating on fossil fuels and Figure 2 (Heli and SCSP), shows the mechanism of the operation of that station. Concentrated solar Energy technologies have an important advantage over PV cells, through storing heat is easier than storing electricity. therefore each station was provided with a special system for storing heat transfer fluid used when sunlight is not available directly, by transferring the stored heat to the steam turbine to pursue the electricity generation, as well as a single-axle sun tracking system that provides the best possible use of sunlight. These type of station requires direct exposure to sunlight and wide and space areas to produce electricity on a large scale as shown in Figure 3 (Khalid Abdul Wahab, 2013).

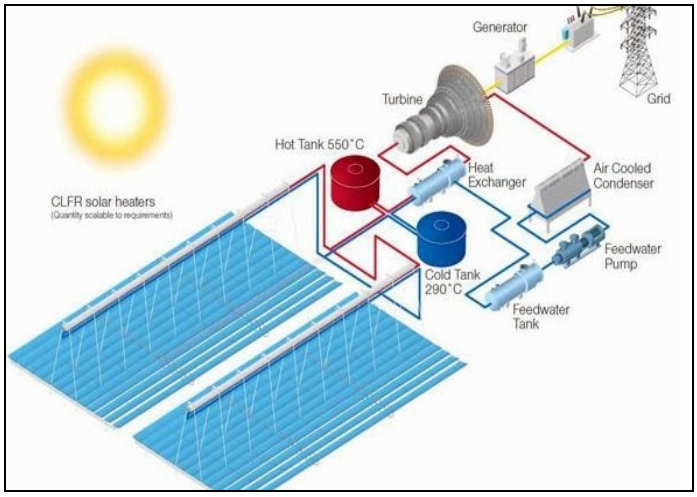

Fig. 2: concentrated solar energy technology

Fig. 3: Solar power plant model

Environmental requirements and the usage of renewable sources in residential complexes

The relationship of the Sun's location to any point on the Earth's surface was defined by the azimuth and elevation angle, these factors determined by the date, time, and latitude. Both angles play an important role in setting the orientation of the building, the orientation of 35 degrees towards the north generally acceptable for buildings in Iraq. The largest and smallest angle of the sun's rise in Iraq during the year is at noon at 22 June 30 78 degrees At noon at 22 December 30 31 degrees and on it. The best guidance for buildings in the dry hot zone is 35° East South and the best route for buildings in the humid hot zone (southern region) is

15° East South according to Iraqi Urban Standards (Khalid, 2013). The focus on the investment of renewable energy sources in bridging energy demand in residential complexes has become urgent in the light of the large deficit in the electric power system as well as the resulting increased environmental risks. Masdar city in Abu Dhabi, United Arab Emirates as an ecological model, which was 100% depended on renewable energies in generating their electrical needs. The main treatments presented by this scheme were the shift in addressing the energy problem from the single building level (design level) to the city level (planning level) by introducing a new use of land for energy production (Khalid, 2013). This development has emerged as a special plant for solar energy systems in and around the city and a farmer of linear wind turbines along the south-west and north-eastern edge of the city, as well as the distribution of a number of small wind turbines within the buildings within the city, as the stations were designed Geothermal energy and waste power plants to employ biomass as a renewable energy source in the city (Lau, 2012).

Experimental Study

A six residential compound located in Baghdad governorate (Bismayah, Al-Zuhoor, Iraq Gate Complex, Jawaher Dijla, Al Ayadi Complex, and Al Yamamah city compound) were considered as the main field of this study, which named as (B1, B2, B3, B4, B5 and B6) respectively. Table 1 represents the demographic information that obtained according to data collected from each compound, while the sequence of compounds was listed by the largest number in the housing units B1 to the lowest number B6 compound. The Bismaya residential complex B1(Bismayah.org, 2015), was located within the administrative boundaries of Baghdad city with an estimated (10) km, which was a positive step to reduce the traffic jam and absorb the momentum of the population. Al-Zuhoor residential compounds (Economy and investment, 2018), which located south east of Baghdad along Mohammed al-qaism highway While the rest of the complexes are located within the administrative boundaries of Baghdad city as exemplified by the Iraqi gate complex (Baghdad Investment Commission, 2018) which located at Al-Muthanna Airport on one side and the other Al-Zawraa Park, Jawaher Degla complex(Jawharat ALmuhit, 2017), which located Kadhimiyah city on the banks of the Tigris River, the Al-Ayadi complex (Iraq Projects, 2017), which located West Baghdad/ Amreya district. Finally, Yamamah city at Al-Adel district/alley 645, the other data such apartment number, area, and building number in each compound were given in Table 1.

Results and Discussion

The research showed that there was no use of solar energy in any electrical field in the compound was in the apartment itself or the streets and parks or other uses as shown in Table 2. However, there was a possibility to use them as there were good areas to spread the cells on the roofs and on the facades of buildings, windows and others, thereby reducing the load on electric power, since the use of electric power is constantly increasing over the years 2012, 2013 and 2014 According to data that obtained from the Ministry of Electricity as shown in Table 3, without significantly expanding the electrical stations. All the housing compounds have agreed on the possibility of using solar energy for lighting and other purposes as well as the availability of sufficient space for use in the roofs of residential buildings and unused spaces.

Table 4 shows the use of intelligent Systems in electrical fittings in each compounds, where all them agree that light sensors are not used for the purpose of outdoor lighting on the streets within the residential complex, Except B1 that implements this technique. While in case of the Stair outdoor lighting, only B1 was implement the IntelliSense technology when door open and closed, therefore all the housing complexes must follow the same steps in order to reduce the wastage in electrical energy. As for the use of energy-saving lamps in out-door and in-door lighting, all residential compound agreed to use them as a substitute for traditional lighting and to reduce the temperatures emitted from them and their impact on global warming. Furthermore, The B1was characterized by the availability of a power station and, at the same time, the surplus of this power was transferred to the government electricity network, which is distinct from other complexes that have formed a addition load on the network as shown Table 3.

All the residential complexes agreed to use gas in the kitchens through pipes except the B5 compound, where gas was supplied by the cylinders, which considered a huge structure design mistake. While all the residential complexes do not use a smart water systems in the complex facilities such as kitchens or toilets as shown in Table 5, and only one compound used smart water systems in the gardens as well as one complex using bathtubs (bathtub) in Baths which consume water at a rate of (2-3) times more than shower system, and at the rate of double of the classical system which consider a high rate of water consumption within the increase in the population, climate change the high per capita consumption of water. According to the collected data that listed in Table (7, 6), it was necessary to provide reverse osmosis stations in these compounds to desalinate water to reduce the onus on the Mayoralty of Baghdad and the self-sufficiency of the residential complexes, the data also indicated the absence of waste water treatment plants except B1 compound.

Table 6 Represents waste water treatment and solid waste disposal methods, only B1 complex was contained a wastewater treatment plant which considered an important step to be adopted in the rest of the future residential projects. As well as the current compounds in terms of studying the possibility of achieve this type of stations, to reduce the onus on the Mayoralty of Baghdad since there was no significant change in the number of central processing plants in three years according to the data that collected from the Ministry of construction and housing and municipalities and public works as in shown in Table 7 and 8. Furthermore, the study showed only B1 dealing with a solid waste transport company as in table while the remaining compound dealing with company that affiliated to the Mayoralty of Baghdad. considering the amount of waste generated from the these compounds and the daily waste rate per person, this was a onus on Mayoralty of Baghdad with the high amount of waste generated per capita. Table 9 represents the type of material that used in the residential building construction complexes, which differed between the use of prefabricated construction such B1 compound), or typical columns beam system with thermostone block, red and yellow bricks as main partitions walls, as well as in the use of doors, windows and glass.

Table 1: Demographic information for study sample

Compound	B1	B2	B3	B4	B5	B6
Area m^2	18.300.000	435.500	300.000	125.000	120.000	80.000
Number of units/apartment	100.080	5200	3269	1500	1300	868
Apartment Area/m^2	100/140 /120	80/100 /125/150	167/ 172/ 199 /215/ 252	137/182 /203	163/195 /350/400	125/ 165
Number of buildings in the complex/ building	835	120	49	13	37	28
surface area of one building/m^2	1320/ 1584/1848	352/ 440/550/660	919/946/1386 1095/1183/	1523 /1602/1787	717/858 /1540/1760	550/726
Buildings area only /m^2	15840	60.060	54.185	21.285	45.094	17.864
Number of floors/floor	10	11	17/14	A12/B5	8+ Duplex	10A /7B/7C

Table 2: renewable energy (solar model) using possibility

Compound	Solar-powered system	Possibility of using solar energy	Enough space to use solar energy
B1	No	Yes	Yes
B2	No	Yes	Yes
B3	No	Yes	Yes
B4	No	Yes	Yes
B5	No	Yes	Yes
B6	No	Yes	Yes

Table 3: Distribution of electric power sold according to consumption categories distributed in Baghdad regions (Ministry of Electricity - Information Center)

Years	Directorates	Total Sales (MW/Hour)	Consumption items					
			H.%*	C%*	G.%*	A.%*	I.%*	IU.%
2012	Al-Rusafa	2366416	38.2	11.5	25.9	14.8	7.4	2.3
	Al-Karkh	3821771	45.0	9.2	28.2	12.5	3.3	1.7
	Al-Sader	1822507	64.5	8.8	15.5	1.5	0.4	9.4
2013	Al-Rusafa	2739721	37.0	14.4	29.4	1.7	15.9	1.7
	Al-Karkh	5337708	42.9	10.4	36.4	1.5	6.0	2.9
	Al-Sader	2341711	65.3	15.0	11.6	0.3	1.1	6.7
2014	Al-Rusafa	2951965	43.3	14.4	30.6	0.7	9.3	1.7
	Al-Karkh	5918422	46.2	12.4	31.2	2.2	5.6	2.3
	Al-Sader	2618363	66.2	12.3	14.0	0.1	0.7	6.7

Note :- H: home, C: commercial , G government, Agriculture , I: industrial and IU: ill-legal using

Table 4: Use of electrical power (intelligent Systems in electrical fittings)

Complex	OLRIC*	ELSIC*	ESLOL*	ESLIL*	EPG*	TFU*	GUC*	HCS*
B1	Yes	Yes	Yes	Yes	ST	Gas	Pipes	SU
B2	No	No	Yes	Yes	SE	-	Pipes	SU
B3	No	No	Yes	Yes	SE	-	Pipes	SU
B4	No	No	Yes	Yes	SE	-	Pipes	SU
B5	Yes	Yes	Yes	No	SE	-	Gas Bottles	SU
B6	No	No	Yes	Yes	SE	-	Pipes	SU

Note: OLSIC. Outdoor lighting on the Road inside the complex, ELSIC. Outdoor lighting in the stair inside the complex, ESLOL. energy-saving lamps in outdoor lighting, ESLIN. energy-saving lamps in indoor lighting EPG. Electric power generation, TYU. type of fuel used, GUC gas used for cocking, HCS heating cooling and system, SE state equipment, and SU split unit.

Table 5: Water use in residential complexes

Sequence	Residential Complex	SWSP *	SWSK*	SWSB *	Bathtubs in bathrooms
1	B1	Yes	No	No	No
2	B2	No	No	No	No
3	B3	No	No	No	Yes
4	B4	No	No	No	No
5	B5	No	No	No	No
6	B6	No	No	No	No

Note: SWSP, K A Smart Water System in Parks, Kitchen and Bathroom

Table 6: Treatment of waste water and solid waste in residential complexes

Compound	Treatment station	Waste lifting
B1	Separate	Specialized company
B2	State responsibility	State responsibility
B3	State responsibility	State responsibility
B4	State responsibility	State responsibility
B5	State responsibility	State responsibility
B6	State responsibility	State responsibility

Table 7 : Number of small-scale treatment units , Baghdad sewerage Department design by governorate for the year 2012 (Ministry of Municipalities and Public Works)

The municipality	NSP* %	TDC* %	AQWW* m^3/day	AQWW** m^3/day	PTWWG %*	PTWWG %*
Mayoralty of Baghdad	0	0	0	0	0.0	0.0
Around of Baghdad	0	0	0	0	0.0	0.0

Table 8 : Number of small-scale treatment units , Baghdad sewerage Department, design by governorate for the year 2014 (Ministry of Municipalities and Public Works)

The municipality	NSP* %	TDC* %	AQWW* m^3/day	AQWW** m^3/day	PTWWG %*	PTWWG %*
Mayoralty of Baghdad	5	75000	75000	75000	100.0	100.0
Around of Baghdad	0	0	0	0	0.0	0.0

Note:-NSP: Number of small treatment unit, TDV, Total design capacity, AQWW, average quantity of waste water, AQWW** actual quantity of waste water, and PTWWG proportion of treated waste water to the generator.

Table 9: Residential building construction details.

Comp.	UIC	BT	GT	DWT	TWA/A	EWS	PGB	ARTR	RW
B1	Walls /ceilings/ Flooring	ready building/ thermostone	Single	PVC	20-10	No, it can be saved.	No, it can be saved.	15- 20	Asphalt
B2	Roof /floors	Red Bricks	Single	ALum. /PVC	10- 20	Yes	No, it can be saved.	50	Asphalt/Stone
B3	Roof /floors	Red Bricks	Single	Alum	10- 20	No, it can be saved.	No, it can be saved.	50	Asphalt/Stone
B4	Roof /floors	Red Bricks thermostone ready building	Single	ALum	10- 20	No, it can be saved.	No, it can be saved.	50	Asphalt/Stone
B5	Roof /floors	Yellow Bricks	Single	ALum	10- 20	No, it can be saved.	No, it can be saved.	50	The Stone
B6	Roof /floors	Red Bricks	Single	Aluminium	10- 20	No, it can be saved.	No, it can be saved.	60	Asphalt/Stone

Note : ITC: Insulation technique in construction, BT. building type, WGT, window glass type. DWT. door and window type, TWA/A. total window area/apartment. EWS. existence of windows shadow, PGB presence of green built, ARTR. approximate ratio of tree/ road, RW. road wearing

Table 10: Design of the residential complex for solar rays

Residential Complex	Sun's orientation been studied in the design of the housing units	Using of sun louvers over windows and door
B1	Yes	Yes
B2	Yes	Yes
B3	Yes	No
B4	Yes	No
B5	Yes	No
B6	Yes	No

The investigation results showed that the best complex among the study sample was is B1 complex followed by the rest of the compound in sequence (B2, B3, B4, B5, and B6) in terms of distance from the center of the city, the number of housing units, uses of electricity, water, treatment plants, waste removal, and construction methods, etc.

Recommendations

- Encourage the concerned authorities to go towards the large-scale residential complexes that are somewhat distant from the city center reduce the traffic jam.
- Encourage the authorities to use of solar energy in residential compound by exploiting the surface areas of buildings as well as in streets, roads lighting.
- Urging the investors in the residential compound to use smart systems in the use of electric power, as an example in the stairs and corridors in the buildings and in the interior and exterior lighting.
- A separate electrical power station for each residential project to reduce the onus on the national electricity network and support it with the surplus .
- Require the management of the residential project to use smart water systems for streets, kitchens and toilets.
- Water treatment plants should designed as main part of project to reduce the load on government stations.
- Green belts have been a part of the planning landscape as well as planting the areas within the compound with plants and trees.
- Using the stone material in paving the streets and sidewalks instead of asphalt material for the purpose of reducing heat.
- Using of sun louvers over windows and doors to reduce the heat impact on apartments.

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