

## **Sustainable Development and Their Success Effects on Biomass Energy Production in South West of Sulaimani City**

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**Abstract:** Sustainability means process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. Sulaimani city is located in Kurdistan Region of Iraq, the new master plan of Sulaimani proposed to lead for sustainability and for more green areas in the city. The biggest reason that face the new master plan of Sulaimani is Tanjero as multi land used area and Tanjero River. Tanjero is located at the South West of Sulaimani city also it is considered as part of 2020's city (new smart city) to achieve the principles of sustainability and its pillars. The choice of Tanjero was due to its location where heavy environmental pollution exists which caused by the surrounding areas, as water pollution occurred as a result of shortage in the water filtration system. Pollution of Tanjero River caused an environmental pollutions and health problems for Tanjero and the surrounded areas. Tanjero River is considered as the main problem for implementing of Sulaimani city master plan. In order to solve this problem, the researchers are applied some sustainable techniques that lead to environmental protection and cleaning the damaged areas of Tanjero, good economic base for the 2020 city and solving electrical production problem of Sulaimani city by using the Sulaimani waste as a resource behalf of using other limited resources, also to make the Sulaimani master plan much suitable to be implemented. Waste Management is applied as main sustainable techniques for solving existing problems. Concept and issues related to using sustainability methods and precisely biomass as a source of energy are discussed in this study. The daily Sulaimani wastes will use as a source to generate energy by using factory that change organic waste to clean energy. Note that, Sulaimani solid wastes is reached to 1200 tons, also the waste carried by Tanjero River reaches to 960 tons per day.

**Key words:** Sustainability, Tanjero River, Sulaimani, solid waste, economic, clean energy

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### **INTRODUCTION**

Sustainability (from sustain and capacity) is the property of natural frameworks to stay diverse and productive indefinitely. Extensive and healthy solid wetlands and forests are examples of sustainable biological systems. In more general terms, sustainability is the continuance of frameworks and processes. The organizing principle for sustainability is sustainable development which includes the four interconnected domains: ecology, economics, politics and culture. Sustainability science is the study of sustainable development, natural and environmental science (James, 2015).

Sustainability is defined as a requirement of our generation to manage the resource base such that the average quality of life that we ensure ourselves can potentially be shared by all future generations. Development is sustainable if it involves a nondecreasing average quality of life" (Asheim, 1994).

Sustainable development is the organizing principle for meeting human development goals while at the same

time sustaining the ability of natural systems to provide the natural resources and ecosystem services upon which the economy and society depends.

The attractive end result is a state of society where living conditions and resource use continue to meet human needs without undermining the integrity and stability of the regular frameworks. 'Sustainable development' refers to the holistic approach and temporal processes that lead us to the end point of sustainability" (Shaker, 2015).

The idea of sustainable development has been and still is subject to feedback. What precisely is to be sustained in sustainable development? It has been argued that there is no such thing as a sustainable use of a non-renewable resource, since, any positive rate of exploitation will eventually lead to the exhaustion of Earth's limited stock this view renders the industrial revolution as a whole unsustainable. It has also been argued that the meaning of the concept has opportunistically been stretched from 'conservation management' to 'economic development' and that the Brundtland report promoted nothing but a business as



Fig. 1: Scheme of sustainable development: at the confluence of three constituent parts

usual strategy for world development with an ambiguous and insubstantial concept attached as a public relations slogan. “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. Figure 1 shows the linkage between culture and sustainable development the focus “Addressed the social and economic opportunities and requirements to mainstream investments in cultural heritage and the living arts” (Serageldin and Martin-Brown, 1999).

**What is the difference between sustainability and sustainable development?** Since, the world is not unanimous on defining the needs of human beings (often confusing between needs and wants), it is hard to correctly differentiate between sustainability and sustainable development.

Sustainability looks at saving the environment as the primary objective while sustainable development focuses on development of infrastructure, keeping the environment clean, to achieve growth.

Sustainability is focused on reducing consumption and changing our lifestyles to save the environment. On the contrary, sustainable development focuses on establishing infrastructure that will in effect induce a steady incline of economic growth while keeping the environment clean (Dunkwu *et al.*, 2016).

Sustainable development of south west of Sulaimani city and their success effects on other dimensions. The world is embracing sustainable development and biomass energy as a new model of getting energy as an sustainable and alternative source.

Present technological advances in renewable energy sources make them more cost-effective and efficient than in the past. Renewable energy sources are any sources of energy that can be utilized without depleting their reserves. Renewable energy sources include micro/mini hydro power, wind energy, geothermal, solar energy and biomass.

This study is considered as the foundation of applied research project, it begins with definition of biomass energy and sustainable development of south west of Sulaimani city this is followed by some information about sustainable development how to achieve it and the importance of biomass energy in Sulaimani city due to some serious factors a discussion of pros and cons of the area of south west of Sulaimani is given, also how to implement the project by using biomass and what’s the effect of this project if implemented in the all dimensions of energy, economy, social, etc. A comparison of biomass energy cost to other types of energy is made. Analysis techniques have been applied.

## MATERIALS AND METHODS

The researchers performed this study in order to provide solution for the problems that occurs in the border of Sulemani and Tanjaro as well as in Kurdistan Region of Iraq. The choice of Tanjaro was due to its location at south west of Sulemani city where heavy environmental pollution exists which caused by the surrounding areas as water pollution occurred as a result of shortage in the water filtration system. As a solution for all of these problems by improving the quality of Tanjaro water and designed an electrical power station that intakes waste from oil refining stations. This has various advantages such as economic, social and environmental benefits for Tanjaro and all Sulemani cities and could be used as a sustainable energy source.

**What is biomass?:** Biomass is fuel that is produced from organic materials, a renewable and sustainable source of energy used to power or different types of energy. A few cases of materials that make up biomass powers are: scrap amble; forest flotsam and jetsam; certain harvests; manure and some sorts of waste deposits. With a steady supply of waste from development and demolition activities, to wood not utilized as a part of papermaking, to municipal solid waste-green energy production can continue inconclusively.

Biomass is a renewable source of fuel to produce energy because: waste residues will always exist in terms of scrap wood, mill residuals and forest resources and properly managed forests will always have more trees and we will always have crops and the residual biological matter from those crops. Re-energy holdings is an integrated waste fuel/biomass renewable energy company. Our facilities collect, process and recycle items for use as fuel as well as green energy facilities that create power from that waste (Klass, 1998). Types of biomass are wood and agricultural products, solid waste, landfill gas and biogas, ethanol, biodiesel, etc.

**Energy crisis in Kurdistan:** During the 1970's when the oil price increased, some of countries in the Middle East utilized oil income to build up a foundation of a modern state and create other sources of income rather than oil. This is what happened in UAE, Qatar and Kuwait while other countries tended to use the huge oil income to buy weapons and build a militarized society, the wars and consequent political and social changes in Kurdistan Region of Iraq has created a number of crisis and challenges for the region, including energy crisis, limited economical, agricultural and industrial infrastructure in the region have further escalated the crisis. Pre-1990 Gulf War I Iraq had a large electrical network consisting of 32 thermal, gas turbine and hydro power stations with the installed capacity of 10,200 MW. Only two of these stations are located in Kurdistan Region, Dukan and Darbandikhan hydropower stations with a total installed capacity of 640 MW.

This means that only 6% of installed capacity of electricity generation in Iraq has been built inside the Kurdistan Region. If this compared with the Kurdistan Region population which is nearly 17-19% of Iraqi population, then it will become clear that there is uneven distribution of power stations over Iraq. Today, after the collapse of the former regime and as a result of a long period of destructive policy to wars Kurdistan Region, the region suffers from extreme shortage of energy resources, despite huge reserves of fossil fuel. Local government still is not capable to guarantee fuel and energy supply to the region perhaps because of political response from a semi-independent Kurdish entity.

According to the directory of Kurdistan Region Dispatch Control Centre which is operating the power transmission and distribution network within the region, Kurdistan electricity demand reached over 3058 MW at the end of 2015 and is expected to grow by 5% for the next years due to development and reconstruction. This rapid growth is due to lack of investment in the previous decades (Table 1 and 2) (Husami, 2007).

**Crisis and pollution of Sulaimani city:** Sulaimani city which located Kurdistan is affect by these crisis and environmental pollutions. Tanjero River which located of the South West of Sulaimani city polluted by the sewage of city and the refinery which located of the river and it is pollution the surrounding along the entire river and threatening the people live. According to a study by Hiwa hospital which is for diagnosing and treating cancer year after year, infection rates increase in Sulaimani and raises in the region. Infections to the cancer between 2007 and 2013 is like (Table 1) and according to study by Hiwa hospital the infection in the Darbandikhan is 171 persons in 2013.

**Tanjero:** Tanjaro is located in the Southwest of Sulaimani city (12 km from the city center as shown in Fig. 2. The growing population in Sulaimani city (Kurdistan Region, Northern Iraq) has led to high appearance of solid waste, reaching up to 1,200 tons per day in the last depending upon the Sulaimani governorates. The industry zone in Tanjero area has been characterized by an increasing number of factories for industrial products.). Waste warehouses and fuel tanks are spread randomly without any controlling or a concept for environment protection: The industrial remains are dumped in an uncontrolled manner in a fenced but non-supervised site and a landfill site has not been constructed. The area of the landfill is about 50 ha, allocated for the municipal waste dumping. The waste is in the agriculture lands which polluted all agriculture lands. The wells around the waste

Table 1: The amount of infection in Kurdistan

Years	Cancerous in Kurdistan	Cancerous in Sulaimani
2007	788	575
2008	1225	894
2009	1346	982
2010	1443	1053
2011	1718	1254
2012	1900	1387
2013	2283	1666

Table 2: Existing and projected power stations and demands in Kurdistan (Husami, 2007)

Years	(MW) generate in Kurdistan	Imported fedrel net.	Power (MW) Turkey	From Iran	Planned generation (MW)	Total power (MW)	Estimated Erbil	Sulaimanyah	Demand Duhok	Total	Growth %	Power storage(MW)
2004	184	0	0	0	0	184	300	335	250	885		-701
2005	180	0	0	0	0	180	354	395	295	1044	18	-864
2006	186	134	155	0	0	475	442	476	322	1240	19	-765
2007	186	172	155	0	0	513	522	562	380	1464	18	-951
2008	200	200	155	0	650	1205	615	663	448	1726	18	-521
2009	850	200	0	200	600	1850	708	762	516	1986	15	-136
2010	1450	200	0	200	200	2050	786	846	572	2204	11	-154
2011	1650	200	0	200	200	2250	872	939	635	2446	11	-196
2012	1850	200	0	200	200	2450	942	1014	686	2642	8	-192
2013	2050	200	0	200	200	2650	989	1065	720	2774	5	-124
2014	2250	200	0	200	0	2650	1038	1118	756	2912	5	-262
2015	2250	200	0	200	200	2850	1090	1174	794	3058	5	-208



Fig. 2: The daily amount of garbage and biomass content in garbage

dump area have been contaminated by certain chemical elements, causing changes in the quality of the pumped water and the suitability for human consumption.

Tanjero River is a permanent flowing along the Southern border of Sulaimani city and feeding in East-South East direction the Darbandikhan Lake. This small river is polluted from the sewage of the city and some villages around Tanjaro. Tanjaro River and dump area are the main factors for postponed the execution of Sulaimani master plan.

The river banks, along with many open spaces throughout the area are also used a dumping grounds for construction wastes as well as industrial and municipal garbage. Estimated domestic waste in the Tanjero River is 969 tons per day that's without any other wastes. Also there are 27 oil refineries which refining the oil and dump their wastes directly into the Tanjero River.

**Tanjero landfill:** The landfill contains different kinds of waste with garbage and oil waste dominating (black oil made pool nearby the landfill). Some areas contain remains of tires after they are burned. The oil-liquid nature is mixed with the leachate (result from degradation of organic waste) from the landfill and flows in a canal as a black stream through the nearby agricultural lands until it meets with Tanjero River. the amount of garbage that, we got from Sulaimani governorate in Tanjero landfill (Fig. 2).

**Tanjero River:** The Tanjero River is created from connection of two little streams (Kani-Ban and Qiliansan) with other little tributaries, found south of Sulaimani city that speaks to some portion of Sharazoor plain (horticultural focus in the range) utilized for various sorts of farming and animals utilization. After the improvement

of Sulaimani city, another release added water to this waterway which is sewage emanating. The present review tries to layout the impact of sewage wastewater on the earth of the stream and its bowl.

Today, with expanding the population in Sulaimani city, the water utilization was increased (which brought on increment in sewage effluents). Numerous mechanical establishments were created to cover individual's necessities utilizing the best way to release their squanders by arranging it into Tanjero River (or its tributaries) through sewages with releasing the contaminants into the waterway or its bowl. Stream water is utilized for water system and it is consumed by soil then by plants and these plants are consumed by people and animals as nourishment. Some place these wastewaters reach groundwater framework in Tanjero bowl also (counting a few sections of Sulaimani city) which is multi-utilized by the general population (drinking, residential, modern and water system). Tanjero River flows to Darbandikhan lake (Fig. 3).

**Location of study area:** Figure 4 illustrates the location of study area and the 2020 city.

**Sample of Tanjero water:** The samples were collected from different locations of Tanjero as shown in Fig. 5, meanwhile the Table 3 illustrates the projected coordinates and location descriptions of sample of water. The sample result that the water in the study sites were ranged between hard and very hard.

Tanjero River and tributaries were polluted with heavy metals (Fe, Mn, Ni and Cr) resulting from the impact of sewage wastewater that should be treated before direct discharge into the river, especially, at the Streets No. 5, 12 and 15. Tanjero River and tributaries were polluted with heavy metals (Fe, Mn, Ni, and Cr) resulting from the impact of sewage wastewater that should be treated before direct discharge into the river, especially, at the Streets No. 5, 12 and 15 Mustafa.

**Topography and Land use of study area:** Figure 6-10 illustrate the topography and landuses of study area.

**The illegitimate refinery of Tanjero:** The number of illegitimate refinery discharge that supposed to be closed and removed in the Tanjero River is more than 26 refinery which throughout the all waste into Tanjero River.

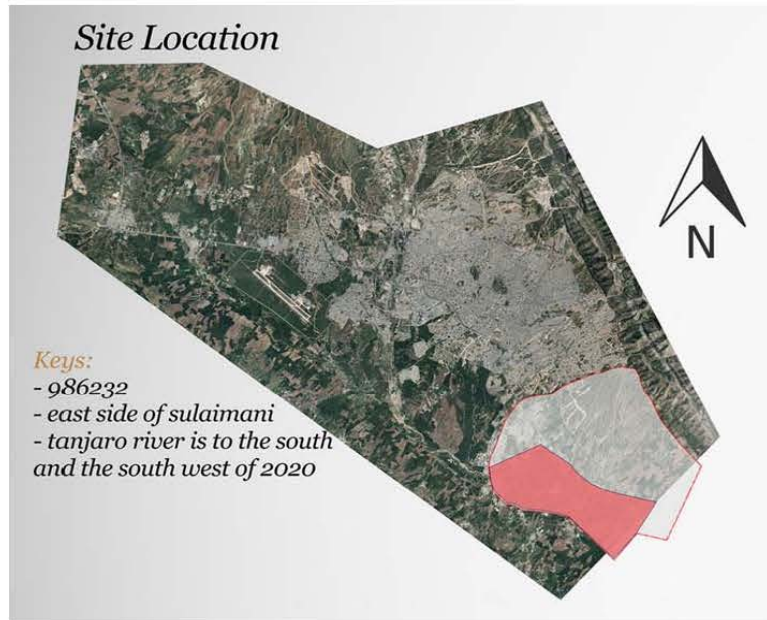


Fig. 3: The location of Tanjero and flow it to Darbandikhan lake

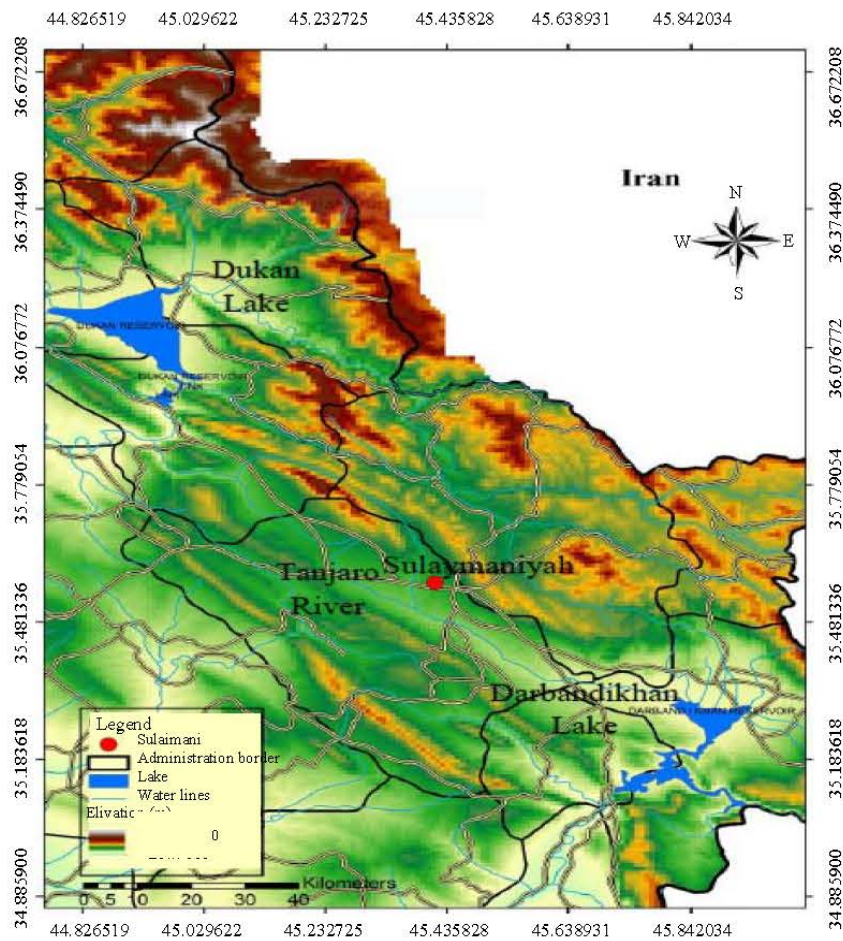


Fig. 4: Location of study area

Table 3: The location of water sample Mustafa

Sites	Description	UTM Easting	UTM Northing
1	Near the Sarchinar cement factory	534232.68	3938602.49
2	Near the Sarchinar cement factory	534180.98	3938405.76
3	Near the Sarchinar cement factory	534214.66	3938246.29
4	Near the Sarchinar spring	534619.44	3938387.15
5	Under Qiliasan bridge	533910.87	3935818.66
6	Near Kostai-Cham and Awal village	533986.17	3933011.62
7	Near Kostai-Cham and Awal village	533876.55	3932155.88
8	Near Kostai-Cham and Awal village	533858.08	3931288.18
9	Below Baba-Ali bridge from the Kani-Ban stream	532793.88	3930780.58
10	From Qiliasan stream before linking with Kani-Ban stream	534424.91	3928937.32
11	From Kani-Ban stream before linking with Qiliasan stream	534079.33	3928711.29
12	After linking Qiliasan stream with Kani-Ban stream	535650.56	3927447.41
13	Near industrial area of Tanjero Regions	537406.31	3926613.56
14	Near industrial area of Tanjero Regions	539474.49	3926397.63
15	Below Tanjero bridge	540168.21	3926237.89

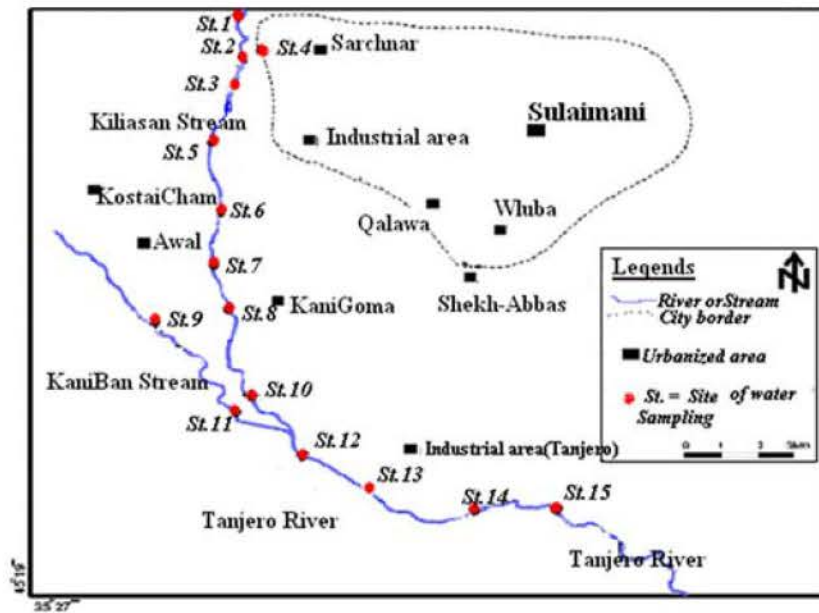


Fig. 5: Location of station of sample water

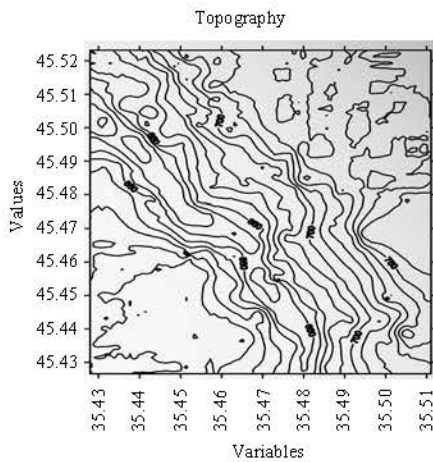


Fig. 6: Contour ma of study area

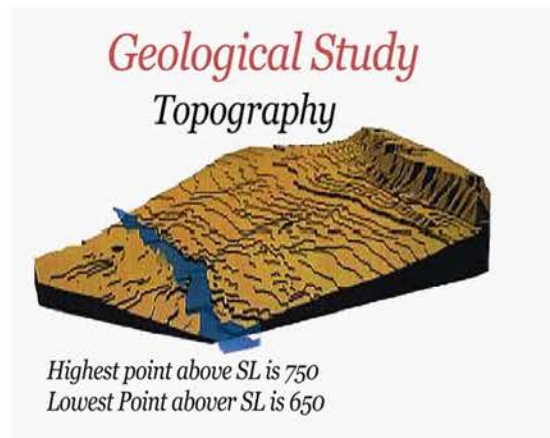


Fig. 7: Digital Terrain Model of study area



Fig. 8: Agriculture land use map

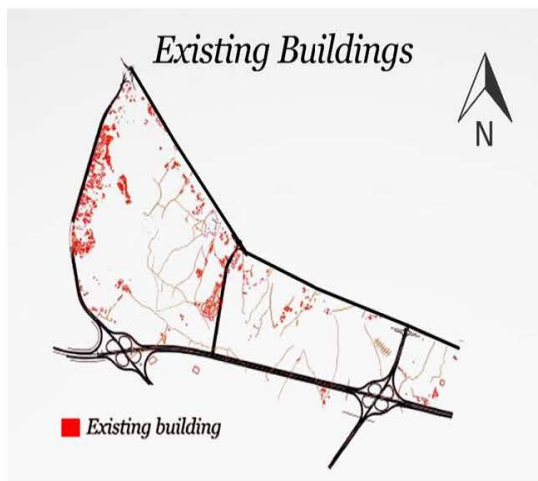


Fig. 9: The existing building inside the Tanjero industrial area

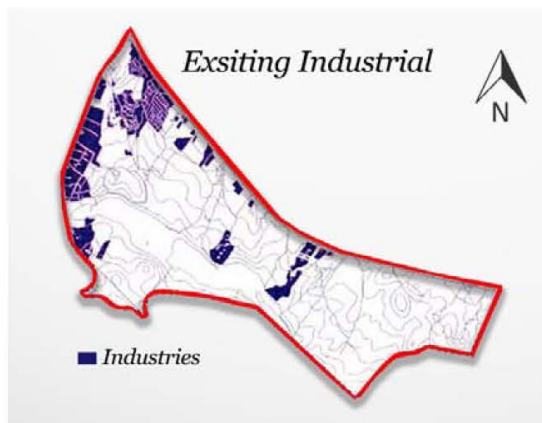


Fig. 10 The existing industrial area

## RESULTS AND DISCUSSION

**Proposed solution:** As mentioned before the aim of this study is to produce electrical energy based on the biomass waste located in landfills and the Tanjero River, therefore, an initial isolation and filtration plant should be constructed in addition to a power plant based on these wastes. First of all the waste should be collected and transferred to the proposed plant near the study area in addition to the collected wastes from waste dumps which reached to 1349 tons per day. Approximately 60% of these wastes can be extracted as a biomass and utilized in waste recycling operations to produce approximately 128 megawatts per day, Fig. 11 and 12 shows the result calculation for producing energy.

### Result calculation:

- Total solid of sewer sludge (kg) =  $979 * 1000 * (0.13) = 127270$  kg
- Total biomass in kg from sewer sludge = 127270 kg
- Total biogass from biomass = 63635 by equation of (biomass\*k) k = biogass factor k = 0.5
- Megajoules =  $63635 * 1.6 = 101816$  MJ
- To convert it to kWh:  $101816 \text{ MJ} / 3.6 = 28282.2$  kWh its equal to = 28 MW
- Total solid of garbage (kg) =  $803 * 1000 * (0.6) = 481,800$  kg
- Total biomass in kg from sewer sludge = 481,800 kg
- Total biogass from biomass = 240900 by equation of (biomass \* k) k = biogass factor k = 0.5
- Mega joules =  $240900 * 1.6 = 385440$  MJ to convert it to kwh:  $385440 / 3.6 = 107966.6$  kwh its equal to = 107.9 MW (Saqlain, 2014) and Biogass calculation, 2014

**Power plant:** The suggested location of power plant is at UTM coordinates (Easting = 535165.58 m, Northing = 3928270.76 m) (Fig. 13), this location is selected to be

<i>Electricity From Garbage</i>	
<i>Tons per day</i>	<b>803</b>
<i>Total solid</i>	<b>%60</b>
<i>Digester Volume</i>	<b>57816 m<sup>3</sup></b>
<i>generated biogass</i>	<b>63635m<sup>3</sup></b>
<i>Electricity Generated</i>	<b>108MW</b>

Fig. 11: The amount of electricity from garbage

<i>Electricity From Sewer Sludge</i>	
<i>Tons per day</i>	<b>979</b>
<i>Total solid</i>	<b>%13</b>
<i>Digester Volume</i>	<b>163167 m<sup>3</sup></b>
<i>generated biogass</i>	<b>6363.5m<sup>3</sup></b>
<i>Electricity Generated</i>	<b>28MW</b>

Fig. 12: The amount of electricity from sewer sludge

closeness to the Tanjaro River and Sulaimani garbage landfill as well as there are agriculture fields in this area and its surrounds which are the main resources for produce biogas that can be used to produce electricity or as LFG (Land Fill Gas).

**Main requirements of the power plant:**

- Construction of digester, bridge, dam, intakes and pipe lines which are the main containment of the station
- Constructing of an area which estimated to 65,000 m square for the station for both garbage and sewer
- Electricity network lines to Zhianaw city and Sulaimani city
- Green built in surround of the station

**Digesters volumes:** Digester volume of garbage is 57816 m<sup>3</sup> which need the cylinder height of 25 m and radius of 35 m digester volume of sewer sludge is 163167 m<sup>3</sup> which need the cylinder with height of 25 and 50 m in radius as shown in Fig. 14.



Fig. 13: The suggested location of power plant

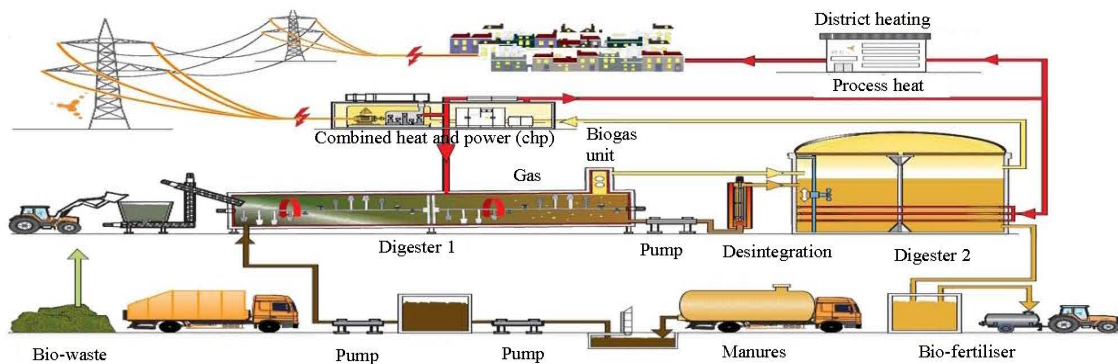


Fig. 14: Flow chart of how proposed systems work



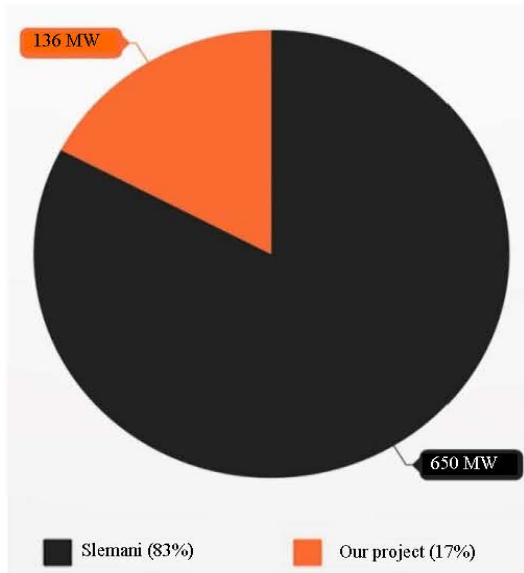


Fig. 15: The ratio of electricity that produce

The electricity generated from sewer sludge is about 28 MW one megawatt can provide electricity for 800-1200 house, meanwhile, the electricity generated from garbage is about 108 MW which is enough to provide electricity to 85,000 homes.

**Discussion of impact of solution**

**Environmental impacts:** The environmental impact which can be considered as a benefit of this application is obtaining a wonderful climate as the region will experience a colder climate about 25 times cooler than the areas where CO<sub>2</sub> is emitted because the biogas makes the area 25 cooler than CO<sub>2</sub> and less of energy will be used. Also using biogas as a source of electricity will make environment of the study area cleanest 22 times than the current condition.

**Economic impact:** The methane gas that extracted from the biomass waste has a greater global warming potential than carbon dioxide, for producing 1 kW it will cost 0.4 cent that is 8 time cheaper than fossil fuel.

The electrical demands of Sulaimani city center (without the surrounding villages or towns) is 650 MW. the researchers solution can provide 136 MW (Fig. 15), if the water of Tanjero is filtered the proposed master plan of Sulaimani it leads to apply which it is to create the boulevard around the Tanjero River that help to clean the environment of Sulaimani (Fig. 16). As a result of this project the area will be cleaned from pollution and it can be used as a 4 zones which are agricultural, food related, building material and medical zone. Its proposed for the

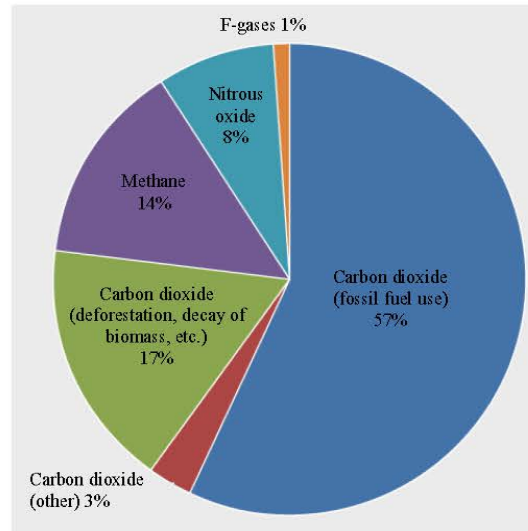


Fig. 16: Global GHG emission

tanjaro industrial area and as a result of this master plan it will cause to lead to sustainability by creating a loop between the zones the waste of agricultural zone will be used in the power station and the waste of food related zone will be shared between power station and agricultural zone, also waste of station will be used in the agricultural.

**CONCLUSION**

Sustainable energy source is gained by improving the quality of Tanjero water and designed an electrical power plant that intakes waste from oil refining stations. This has various advantages such as economic, social and environmental benefits for Tanjero and all Sulemani cities. the researchers solution can provide 136 MW.

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