Biomass energy, Suitable new model in the crisis of fossil fuels consumption in buildings

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Abstract

The term "stability" (sustainability), for the first time in 1986 by the International Committee of the environment as (Faced with the present needs without compromising resources for future generations to meet their needs), was introduced and every day extended on it's dimensions and ranges. It is added to face the appropriate strategies to the world .Today's new attitude toward renewable energy have highlighted, so the biomass as a renewable energy and matchable with the environment is a suitable alternative for energy production. The research is based on library and documental studies. The purpose of this complementary and analytical study performed on the use of biomass for energy production, is to investigate the environmental crisis, to replace and modify sources used for creating energy and equilibrium cycle in nature and to maintain the continuity of turning production and consumption patterns to solve environmental crises. Thereby, finding a suitable model in order to use this energy in buildings and to advantage today's architects and engineers who are taking from this matter

Key words: Biomass , Sustainability, Fossil fuels, Equilibrium cycle, Buildings

1. Introduction

The vast development of science and technology in the nowadays world seems to results in the welfare of human life. However, this development has caused new problems for humans including environmental pollution, wide changes of weather within earth ,etc., Particularly, we know that oil and its derivatives is the valuable national and vital resources of country where sometimes their non−optimal usage leads to irretrievable losses, so authorities and experts seek resources which could be replaced by fossil fuels gradually. Fossil fuels impose numerous environmental pollutions. Burning fossil materials pollutes the environment by producing toxic gases, which makes the human respiration difficult. On the other hand, the congestion of these gases in the earth atmosphere prevent heat exhaustion from its surrounding and results in increased air temperature and vast changes in the earth's weather, which is called greenhouse effect. The main question of this research is that which patterns could respond the requirements of present generation in order to produce energy and consumption in this current era and thereby, to find a pattern, which considers the interests and resources of future generations. The modern energy systems must be based on structural and fundamental changes in the future where the carbonless energy resources like solar and wind energy, thermal energy and neutral carbon like biomass energy are applied. Garbage and wastes are the problems encountered in most metropolitans, so adoption of appropriate systems to collect and transform these organic wastes has high significance. It is so interesting according to the energy production process from the biomass resources not only due to economical factors, but also due to environmental issues. The appropriate abundance, easy access, environmental economical advantages has resulted in this fact that biomass has found appropriate position among the modern energies within globe. Obviously, renewable energies play an important role in the modern energy systems within globe due to the simplicity of technology over nuclear energy technology, as it is free from problems of atomic wastes. Therefore, in the international plans and systems like plans of United Nations organization a particular role has been assigned in the renewable energy resources for stable worldwide development.

2. What is biomass?

Biomass includes whole materials within nature, which were close to living in the past, resulted from the organisms or their wastes. **A biomass resource under particular pressure and temperature conditions produces** fossil resources. The Europe union following proclamation 2000/177/EC, has introduced the definition of biomass as follows in order to develop the usage of biomass in power production in the domestic market of Europe. "Biomass is the whole renewable biological components of agricultural products, wastes (including herbal and animal materials), forest industries and other related industries, biological and industrial renewable wastes and rubbish". (http://www.suna.org.ir/ationoffice-zisttoodehofficezisttoudehenergyfa.html)

3. Exploitation history of biomass

From the historical viewpoint, the date of using biomass energy backs to the early eras of history of using fire. The early human had always used the dry wood and leaf of trees as fuel. This state has continued until present century. Bili NiRous have reported the oldest case of gas exhaustion and its incomplete ignition via waste disposal in the basements. Wen Helmont introduced the identification and ignition of this gas in 1630. In 1667,Sherli discovered the marsh gas and the most original practical history of using methane gas, the main compound of biogas resulted from the fermented materials was by Volta since 1776 and Kain executed the scheme in 1884 and had provided the lightness of Paris streets by using biomass energy. During 1985 to 1990 the mean annual consumption of biomass energy was 14 quadrillion (BTU) in the globe.

Production and consumption of biomass fuels (BTU)	Zone
3.63	North America
0.99	Europe
1.2	Africa
4.4	Asia

Table 1. *Production and consumption of biomass fuels in the 1990–1985 (Publication of renewable energy organization of Iran, 1380)*

In Iran, using biomass has old history. **Muḥammad ibn Ḥusayn al-Âmilî** known as **Shaykh-i Bahâî**, in 935-1031 hijri, was the first one to use biomass as fuel for bath in Esfahan. The first production digester of methane gas in Iran was built in the Niaz Abad village of Lorestan in 1354. This device with capacity of 5 cubic meters uses the cow manure of the village and provides the consuming biogas of adjacent bath. In 1359, it was constructed in an area of three cubic meters in the Bu-Ali Sina University of Hamadan and in 1361, in an area of three cubic meters in the Sharif University of Technology where its fuel was from cow manure. In three cities of Shiraz, Mashhad and Isfahan, the required equipments were applied to use as a biogas in the areas of waste disposal (Publication of renewable energy organization of Iran, 1380).

4. Biomass resources

Plants due to photosynthesis process absorb a part of solar radiation that, reaches to the atmosphere of earth. This is one of the most appropriate energy resources created as a result of photosynthesis and it is multiple times more than the whole usual energy consumption of the globe. About 90 % of this energy stored in the trees is recorded as extractable fossil fuels reserves. Biomass resources, which are suitable for energy production, include a vast range of materials as following groups:

1) Wooden fuels: wood is the main source of biomass energy which human being has used it not only in home usages but also in the vast range of industrial jobs over centuries.

2) Forest, agriculture, gardening and food industry wastes

3) Municipal solid wastes (MSW): the municipal solid wastes include different types of biomass like paper, construction waste and wastes resulted from commercial, office, house and industry operations. By settling these residues within the basement, the biogas could be obtained whereby filtration of the obtained gas; we can use this gas in all the industries and especially as a boiler fuel within power stations.

4) Municipal sewages: sewages resulted from human habitats have substantial energy and as animal manure it could be fermented by anaerobic method and produce methane gas.

5) Animal manures: animal manures can be converted into biogas based on anaerobic digestion. As observed, all these materials have organic materials and are able to ignite. Therefore, each one can be determined with a specific thermal value. The thermal value is a value, which is released from the mass unit of combustible material, and this heat value could be expressed based on the mass unit of either wet or dry material. According to the general following reaction, carbon dioxide and water accompanied with high amount of thermal energy is released from the combination of each organic combustible material with oxygen.

ombustible material + O_2 → CO_2 + H_2O + thermal energy + ash + other gases

5. Biofuels

It is a type of fuels obtained from biomass resources including fluid ethanol, methanol, biodiesel fuels and gas diesel fuels like hydrogen and methane. The researches on biological fuels have three main goals:

1. To produce biofuels

2. To find exploitation methods and use them

3. To determine the sparseness of its constructions

The production resources of these fuels include sugarcane, plant and vegetable oil (publication of renewable energy organization of Iran, 1380).

6. Biomass energy conversion technology

Technologies used to convert biomass into energy include from the simple open vapor systems, which is used in cooking to advance Pyrolysis units for producing solid, liquid and gas fuels. Biomass conversion technologies can be classified into three main classes: direct ignition processes, thermo chemical processes and biochemical processes.

1) Direct ignition processes: direct ignition is a fundamental process used to convert biomass into useful energy. The produced heat or vapor is consumed to generate electricity or provide the required heat for applications like industrial processes, space heating, cooking or heating of different municipal areas. In large industries, furnace and boilers have been improved to burn different types of biomass like wood, wooden wastes, black liquor resulted from operations of providing paper mache, wastes of food industry and municipal solid wastes. These units are so effective and could compete with efficiency of ovens of fossil fuels.

2) Thermo chemical processes: Pyrolysis is one of the most important processes of thermo chemical methods in converting biomass into valuable and suitable products. The generated products include a gas compound, oil like liquid and a thing like net carbon coal. The distribution of these products depends on the amount of store volume, temperature and reaction pressure and duration of gas presence within ignition position and heat rate.

3) Biochemical processes: this type of processes has an application in biochemistry of raw materials and metabolic action of microbial organisms to produce gas and liquid fuels. There are various types of renewable biomass technologies throughout the globe and these technologies are developing.

7. Biomass heating systems

Biomass heating systems burn plants or other organic matter such as wood chips, agricultural residues or even municipal waste to generate heat. This heat can be transported and used wherever it is needed for the ventilation and space heating requirements of buildings or whole communities, or for industrial processes. Biomass heating systems differ from conventional wood−burning stoves and fire places in that they typically control the mix of air and fuel in order to maximize efficiency and minimize emissions, and they include a heat distribution system to transport heat from the site of combustion to the heat load. Many biomass-heating systems incorporate a sophisticated automatic fuel handling system. Biomass heating systems consist of a number of elements, including a heating plant, which typically includes an automated biomass combustion system, peak load and back−up heating system, heat distribution system, and biomass fuel supply operation. The system can also include a waste heat recovery system from a process or electricity generation unit. (Ilias J. Gousgouriotis, et.al., 2007)

8. Biomass combustion system

In the Biomass Combustion System (BCS), the principal interest in a heating plant, the biomass fuel or feedstock moves through the BCS in a number of stages, many of which are illustrated in *Figure 1* and described here :

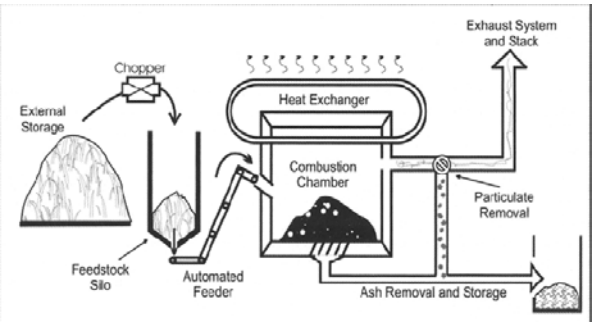

Fig.1. *General layout of a biomass combustion system (Ilias J. Gousgouriotis, et.al., 2007)*

9. Biomass heating economic evaluation model

The methodology presented in this paper can be used to evaluate energy production, life cycle costs and mitigation of greenhouse gases emission for biomass heating installations and/or a waste heat recovery system. The model has been designed to analyse a broad spectrum of applications, from installations in a large scale such as district heating, to individual applications in residential or industrial sector. The evaluation of the biomass heating project (alternative heating system from now on) is carried out in comparison to an existing or a potential heating system using fossil fuel or electricity produced by fossil fuel *(conventional heating system* from now on). To realize the evaluation, a series of technical elements and economic figures is necessary, to determine the financially beneficial installation of a biomass heating system instead of a conventional fuel system. In the first stage, the technological aspect of the investment was studied, where the existing conventional system is analysed and the alternative one is designed so that it fulfills energy supply requirements. Then, after appraising the costs and benefits of each system, a series of economic indexes was calculated, based on which the investment's efficiency can be assessed. (Ilias J. Gousgouriotis, et.al., 2007)

9.1 Models main parameters

The main input data required are listed below:

9.1.1 Site conditions

- Heating design temperature
- Monthly heating degree days below 18~
- Domestic hot water heating base demand
- Heated floor area
- Heating load

This input data is used to estimate the heating energy demand and the peak heating load.

9.1.2 Base Case Heating System characteristics

- Heating fuel type(s)
- Heating system seasonal efficiency
- Unit cost of fuel

This input data estimates the fuel cost of the existing (conventional) heating system.

9.1.3 District heating network

- Design supply/return temperature
- Length of pipe sections
- Use of transfer stations
- Unit costs of pipes and transfer stations

This input data estimates the pipe size of the distribution lines (based on the heating loads) and the cost of the district heating network.

9.1.4 Renewable Energy System characteristics

- System type(s)
- Capacity
- Efficiency
- Moisture content on a wet basis of biomass

This input data estimates the percentage of the annual heating energy demand and percentage of the peak heating load that can be supplied by the renewable energy heating system. In general, the heating system may consist by a *Waste Heat Recovery* system (WHR) or a *Biomass* system or *WHR* and *Biomass* systems combined. Furthermore, it may include a *Peak Load* system to meet a small portion of the annual energy demand during peak heating periods. The *Peak Load* system may consume either fossil fuel or biomass. Finally, provisions were made for the use of a back−up system in case of system shutdown or because of an interruption in the biomass fuel supply.

9.1.5 Initial, annual, periodic costs (or credits)

The most significant initial costs of a project concern costs is for the project development, engineering, purchase and installation of the renewable energy equipment. The annual costs associated with the operation of a biomass and/or WHR heating system includes costs for biomass fuel, peak load fuel oil and parasitic electricity consumption. In addition, property taxes, insurance, spare parts, O&M labour and general and administrative expenses can also be incurred. Periodic cost represents recurrent costs that must be incurred at regular intervals to maintain the project in working condition.

9.1.6 Financial parameters

- Energy cost escalation rate
- Inflation
- Discount rate
- Project life
- Debt ratio/Debt interest rate/Debt term
- Income tax analysis

This input data is used to evaluate the financial viability of the biomass project under alternative financing scenarios.(Ilias J. Gousgouriotis *et.al.,* 2007))

10. International projects

10.1 Sidwell Friends School, Washington, D. C., USA

Sidwell Friends School features a closed−loop system of water recycling, which processes the schools wastewater in a series of outdoor wetland gardens to be reused within the building. Both the SW 12th Avenue Green Street Project and the Blackstone Storm water Garden featured in the Fluid chapter incorporate a decentralized bio−based system for integrated storm water treatment. Designed with a capacity to retain rainfall during storm events, networked planters and bio−swales intercept polluted sediment migration, before the sediment reaches nearby water bodies. (http://www.scribd.com/doc/50364355/Living-Systems)

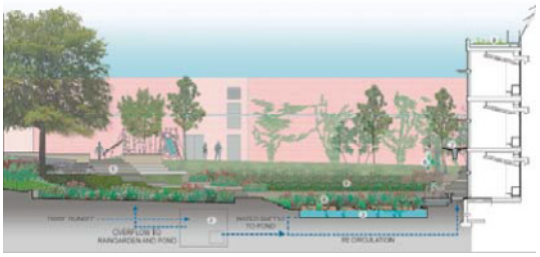

Fig.2. *The wetland system treats sewage and grey water from the building. (www.scribd.com/doc/50364355/Living-Systems)*

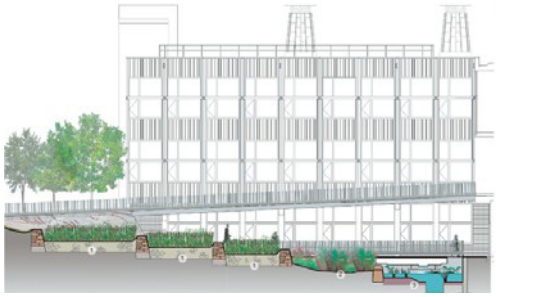

Fig.3. *Illustrated section of wetland treatment systems. (www.scribd.com/doc/50364355/Living-Systems)*

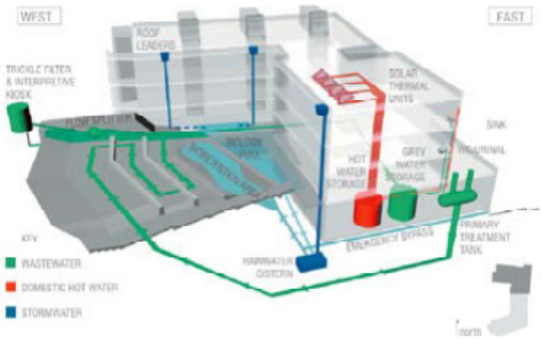

Fig. 4.*Diagram of the closed–loop water system. (www.scribd.com/doc/50364355/Living-Systems)*

Fig. 5.*Perspective visualization of terraced wetlands and new building. (www.scribd.com/doc/50364355/Living-Systems)*

10.2 DaimlerChrysler Plaza, Potsdamer Platz , Berlin, Germany

Water–based resources, such as stormwater surface runoff or building wastewater, are typically categorized within a continual time sequence that requires micro–digestion. For example, the Water–Cleansing Biotope at the Daimler-Chrysler Potsdamer Platz plaza continually metabolizes excess nutrients in rainwater collected from 13 surrounding buildings through a combination of filter substrate and water plants. Various substrates and materials are currently being studied for their capacity to biodegrade excess nutrients or harmful compounds in wetlands, biotopes, and bioswales. (www.scribd.com/doc/50364355/Living-Systems)

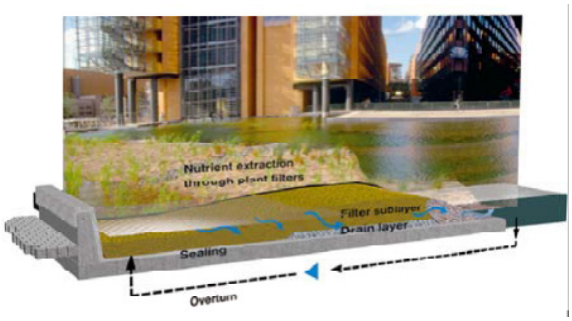

Fig.6. *A diagram of sand–mineral substrate and aquatic plants (www.scribd.com/doc/50364355/Living-System)*

Fig.7. *Constructed on top of a traffic tunnel, the biotope is lined with a geomembrane (www.scribd.com/doc/50364355/Living-Systems)*

10.3 Former British Petroleum Park, Sydney, Australia

Soil−based resources may combine the two scales of Digestive operations by employing both biological remediation via plants, bacteria, or fungus (myco-remediation), as well as macro strategies of cut and fill or concealment (capping). For example, the former British Petroleum Park combines three different Digestive operations: onsite soil bio−remediation; the introduction of coastal wetlands to continually cleanse polluted runoff; and the reuse of the sites infrastructure inorder to redirect runoff to the wetlands. (www.scribd.com/doc/50364355/Living-Systems)

Fig.8. *Plan showing the concrete platforms, where the drums once stood, as they relate to the storm-water detention wetlands.(www.scribd.com/doc/50364355/Living-Systems)*

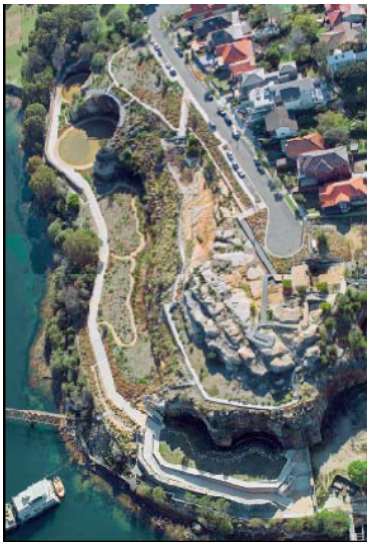

Fig.9. *Aerial photos of existing conditions after removal of drums and of constructed park (www.scribd.com/doc/50364355/Living-Systems)*

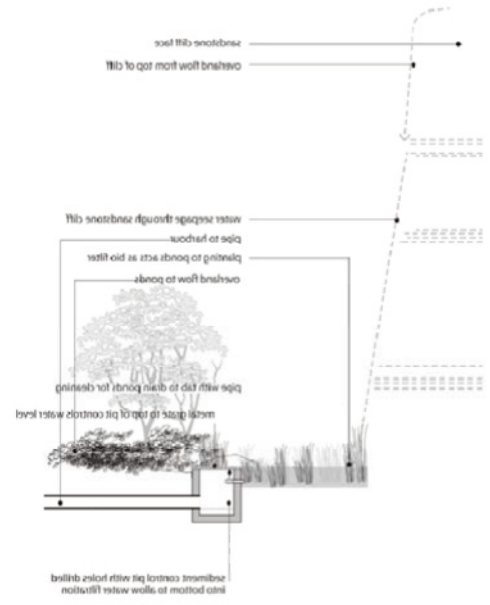

Fig. 10. *Biofiltration ponds and water control pit (www.scribd.com/doc/50364355/Living-Systems)*

Fig. 11.*The emergent landscape and Sydneys skyline (www.scribd.com/doc/50364355/Living-Systems)*

10.4 The University of Hong Kong green–roof research site, Hong Kong

This field–based study in humid, tropical Hong Kong evaluated green roofs of three vegetation types with different growth forms and biomass structure in comparison with a control plot. The passive cooling effect of green roofs was investigated with respect to diurnal temperature variations across the vertical profile. As the first green–roof research in the city, the study could provide practical experience on extensive green–roof establishment and maintenance using different vegetation types. The findings could also provide a scientific basis to support the green roof movement in tropical cities in this region and beyond. (Jim,2012)

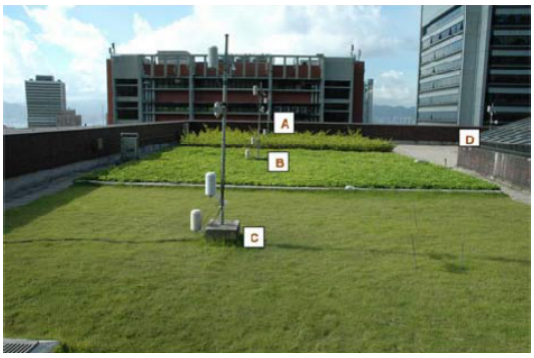

Fig. 12. *Three experimental plots (A, B, C) and the control plot (D) at the University of Hong Kong green–roof research site, with the environmental sensor stations located at the center of each plot (Jim,2012)*

11. Projects of exploiting biomass energy in Iran

1) Performed projects: project of potentiometry of biomass resources in Mashhas and Shiraz

2) Executing projects: construction of biomass pilot in Saveh prodivding biomass atlas in the country feasibility studies and construction of power station of 10 megawatt biomass. (http://www.suna.org.ir/projectdetail/fa–27.html)

12. Conclusion

The date of initial emergence and growth of energy production patterns backs to few last centuries. But in the present century, due to emergence of problems caused by the overuse of fossil fuels and the problems of environmental pollutions thereby, increased the significance of fuel study and energy production. Hence, in developing countries many activities are developed and processed in order to produce energy from clean fuel. Innovation in this field and motivation of all these activities will help to solve the crisis caused by fossil fuels either in the form of limitation or in the form of pollution of environment. We as planners of a set called city or society must consider this important fact in order to create a desirable set and proceed in the path directing activities and researches so that it could improve this replacement in order to minimize the crisis caused by energy production and consumption. In order to achieve the goal of increasing the renewable energy proportion in energy consumption, architects should evaluate the site at the concept design phase. For site planning, the effect of the utilization of renewable energy on buildings and plants arrangement must be considered.

In the construction design phase, constructing nodes, material selection and some other details must be carefully dealt with. On the aspect of management and equipment selection and others, architects should cooperate with the HVAC engineers and communicate with each other thoroughly, so that they can optimize the efficiency of the utilization of renewable energy (Fig. 13). By means of this integrated design, the utilization of renewable energy would not only stay in a stage where several PV boards are placed on the roof, but together with the building, they will become an integral and comprehensive system.(TIAN Lei, QIN Youguo, 2007)

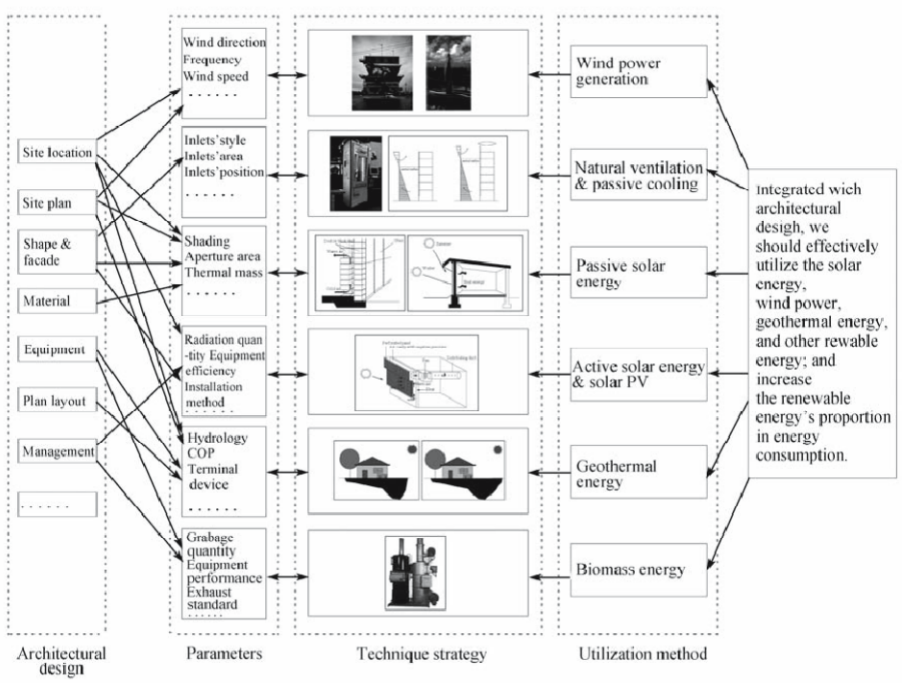

Fig. 13.*Diagram for integrated design method (TIAN Lei, QIN Youguo, 2007 ,p 121)*

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