SAVING ENERGY CONSUMPTION IN THE PHASE OF BUILDING CONSTRUCTION, A STEP FORWARD TOACHIEVE SUSTAINABILITY

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ABSTRACT

Egypt in the scope of the global energy crisis, which threatens to drain resources from traditional energy (non-renewable energy), and it is in a bad need to make energy reduction and to emphasize the sustainability concept.Sustainable architecture, Green architecture and Environmental Architecture all of those trends represents the importance of saving energy consumption through all phases of the Building Life Cycle. This Paper presents an introduction for how to achieve sustainability in construction work, starting from Design decisions (particularly in the selection of building materials and methods of construction) in an attempt to save energy consumption without continuing to drain the surrounding environment.Energy consumption during the construction phase (this phase start from the raw materials used in construction, transporting and Site operating energy until the construction is completed.) represents 40% of the energy of the whole building, and in the absence of a specific method that helps Architects in evaluating the different factors affecting the energy consumption in the construction stage. That can lead to more energy consumption.This Paper aims to achieve the Environmental balance within reducing the Energy Consumption in Construction phase and applying practical actions to reach the sustainability.

Keywords: Egypt-Sustainability – Energy Consumption – Environmentally - Building Construction.

1. INTRODUCTION

The actual optimum utilization of limited power sources is among the most essential issues from the developing nations. The improve in worldwide warming, power resource destruction, and nearby and local pollution possess detrimental effects on the ecological system from the late 1980s. Buildings possess a greater part in worldwide and nearby energy use of the globe and power savings within buildings offers gained importance within the last decades. Energy used throughout the life cycle of building construction includes consuming power in manufacturing (embedded energy), administration and damage phases.

The Production Embedded Energy (which consider the first step in calculating the Building Energy) may be divided into three main parts: material manufacturing, transportation, and erection energy. However, Managing energy is the energy used during the occupation and renovation of buildings. And the Occupation energy mainly includes the energy used for heating, ventilation and household electricity. And finally, the Destruction energy which presents the energy used for the demolition and removal of debris processes at the end of the lifespan of buildings.

According to the report of the United Nations Environment Program (UNEP.2007), energy use of building construction sector account for 30% to 40 % of global primary energy consumption, and therefore contributes to significant greenhouse gas (especially carbon dioxide, CO2) emissions. However Energy Consumption investigation has pointed out that through improving power efficiency, carbon emissions from buildings could be reduced by 22% (European Union 2008).

Although the building industry (BI) is a vital element of any economy, but it has a significant impact on the environment. Through virtue of it's size construction is among the largest users of one's material resources as well as water and it's a formidable polluter. In reaction to these effects, there keeps growing consensus amongst organizations devoted to environmental overall performance targets which appropriate methods and actions are essential to help to make building actions more environmentally friendly (Halliday, 2008), Regarding such substantial influence from the building business, the environmentally friendly building approach includes a high potential to create a valuable factor to environmentally friendly development. Sustainability is really a broad as well as the complex idea, which has turned out to be one of the major issues within the building business. The concept of sustainability entails enhancing the caliber of life, thus allowing individuals to live in a healthy atmosphere, with enhanced social, financial and environment conditions (Barrett, 1999).0 The sustainable project was created, built, refurbished, operated or even reused within an ecological as well as resource-efficient method (Abidin, D. Z. 2010). It ought to meet numerous certain goals: resource as well as energy effectiveness; CO2 as well as GHG emissions decrease; pollution avoidance; mitigation associated with noise; improved indoor quality of air; harmonize using the environment (Ortiz, To.; 2008). An ideal project should be inexpensive to build, last forever with modest maintenance, but return completely to the earth when abandoned (Ortiz, O.; 2010).

2. THE CONCEPTS OF SUSTAINABILITY, SUSTAINABLE DEVELOPMENT AND SUSTAINABLE CONSTRUCTION

2.1. Buildings and the Environment (= WHY?)

The actual quest in the direction of sustainable development within our societies places the spotlight on the built environment and also the construction business. Construction, structures, and infrastructure would be the main customers of assets: materials as well as energy. In Egypt, buildings require a lot more than 40 % from the total power consumption and also the construction field is estimated to create

approximately forty % from the man made waste materials (Sjöström 1998). Environmental burdens caused by construction can be minimized and construction techniques can be used to remedy the environment. The sustainable building could be the reaction in the creating field for the problem related to Sustainable enhancement (Figure 1)

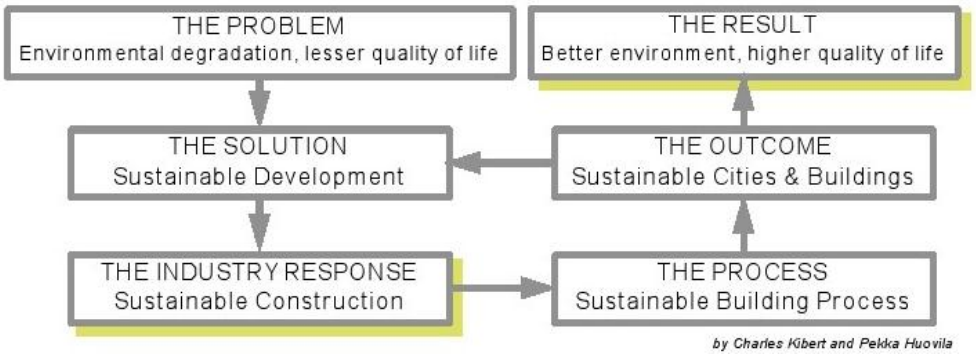

Figure 1: A simplified road map for sustainable construction (Bourdeau et al. 1998)

2.2. SUSTAINABLE DEVELOPMENTDEFINITIONSAND CONCEPT (= WHAT?)

Several attempts have been made to describe the sustainability concept. Sustainable development is defined in any words and from the different point of views. Sustainable development is all about ensuring a much better standard of living for everybody, now as well as for generations in the future. This requires meeting four key objectives at the same time in the world as a whole (Bani Masood. a2007).

- Social improvement which recognizes the requirements of everybody;
- Effective protection from the environment;
- Prudent utilization of natural assets;
- Maintenance associated with higher as well as steady amounts of financial development as well as work.

The primary concept of sustainability would be to focus on environment problems to attain the created item along with optimum inner characteristicsof the environment so that it can minimize the undesirable aspects of these constructions. Buildings must reply to the environment from the design stage and settling when they are to decrease confronting with nature (Bani Masood. a2007). At (Table 1) some of the definitions of sustainability and sustainable development are presented

Table 1: Sustainabilitydevelopment concept

1	**Sustainability**	The concept of sustainability to be used in the corporate community, developing the principle of triple bottom line. Triple main point here refers towards the three prongs associated with social, environment and monetary performance, that are directly associated with the concept and also the goal of sustainable development. They are highly interrelated and are of equal importanceDing.G.K.C, (2008).

2	**Sustainable development**	Requires meeting the fundamental needs of everybody and extending possibilities for economic as well as social advancement Lastly the term also implies the capability of development tasks to endure organizationally as well as financially A development initiative is recognized as Sustainable if along with protecting the atmosphere and creating a chance, it is able to carry out activities and generate its own financial resources after donor contributions have run out." (Bread for the World, 1993)
3	**Sustainable development**	"[**uses]** . . Organic renewable resources in a fashion that does not get rid of or degrade them or else demise their green usefulness for long-term generations while sustaining effectively constant or even non-declining stocks associated with natural resources, for example, soil, groundwater, and biomass (Guide to the Global Environment, 1992).
4	**Sustainable development**	"[Is based on the premise that] . . . Present decisions shouldn't impair the actual prospects with regard to maintaining or even improving long-term living requirements. This means that our financial systems ought to be managed to ensure that we live from the dividend in our resources, sustaining and enhancing the resource base (R. Repetto, 1986).

Whilst traditional style and construction targets cost, overall performance and high-quality objectives, sustainable style and construction increase these requirements minimization associated with resource destruction, minimization associated with environmental destruction, and developing a healthy constructed environment (Kibert 1994). The change to sustainability is visible as a brand new paradigm (Vanegas et al. 1996) exactly where sustainable goals are inside the building style and building industry regarded as in choice making whatsoever stages from the life cycle from the facility (Figure 2) describes the development and challenges from the sustainable building concept inside a global framework

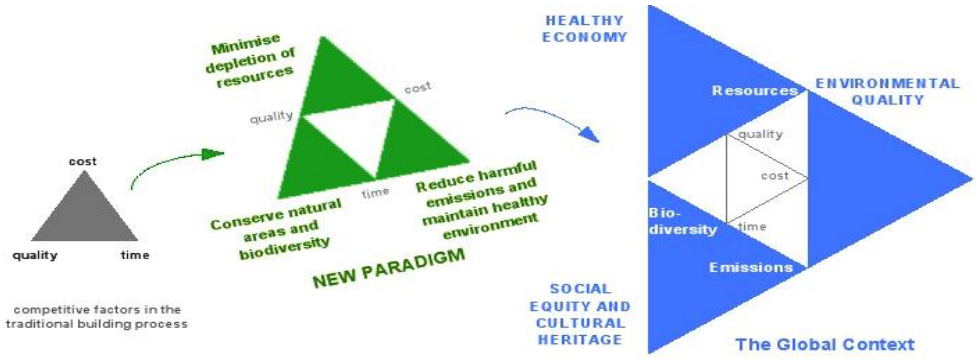

Figure 2: Challenges of sustainable construction in global context (Huovila &Koskela, 1998)

2.3 Sustainable ConstructionImplantation (= HOW?)

Sustainable construction is defined as "the creation and responsible management of a proper built environment depending on resource effectiveness and environmental principles".(Ding.G.K.C, 2008).The Organization for Economic Co-operation and

Development (OECD) project has identified five objectives for sustainable buildings.

- Resource Efficiency
- Energy Productivity (including Green house Gas Emissions Reduction)
- Pollution Avoidance (including Indoor Air quality and Sounds Abatement)
- Harmonize with Environment (including Environmental Assessment) - Integrated and Systemic Approaches (including Environmental Management System).

Recent sustainable building practices are usually widely different based on how the concept of sustainable structure is developed in a variety of countries (Bourdeau et al.1998). The difference between the market economies, transition economies and developing economies influence its implementation priorities. The mature economiespay attention to a sustainable building stock either by new construction or by the refurbishment. Within the transition economies the actual emphasis is upon new developments decreasing the housing lack and improving their own transportation networks Within the developing economies the actual social agenda e grams job creation is a lot higher on the actual agenda than environment concerns.

Table 2: selected definitions of sustainable buildings and construction

1 Sustainable construction (SC)	Sustainable construction describes building actions in whose damaging effects tend to be reduced as well as good effects maximized in order to accomplish the stability when it comes to the environment, financial as well as interpersonal overall performance (Richard, Ur. W, 2006) Sassi. G, (2006).
2 Sustainable construction(SC)	A high-performance property that considers and reduces its impact on the environment and human health (Richard, R.B, 2006) .
3 Sustainable construction(SC)	Healthy facilities designed and built on a resource- efficient manner, using ecologically based principles (Richard, R.B, 2006).
4 Sustainable building	""Sustainable building" can be explained as individuals structures which have minimum undesirable effects about the constructed as well as the environment when it comes to the actual structures on their own, their own instant environment and also the wider local as well as the worldwide environment. "Sustainable building" might be understood to be creating methods, that shoot for essential high quality (including financial, interpersonal as well as environmental performance) in an exceedingly wide method. Therefore, the actual logical utilization of organic assets, as well as suitable administration from the creating share, may bring about preserving rare assets, decreasing power usage (energy conservation), as well as enhancing environment high quality. Sassi. G, (2006).

As well as the “common” sustainability criteria, for example, energy effectiveness, non-toxic or even recyclability a number of other important sustainable measures could be listed. A few examples of which kind tend to be: preserving home value, versatility, long support life, utilization of local assets, information dissemination,

and utilization of by-products, unimportant services, mobility thing to consider or supporting the neighborhood economy (Bourdeau et ing. 1998). The actual building industry needs to adapt to these types of new and rising construction markets, that have environmental and interpersonal dimensions. Construction companies are expected to incorporate into, and think about more fully, the problems valued by other people at national, regional and community level in which the driving forces would have been a mixture of politics, social and marketplace forces, requiring products which react to genuine needs as well as concerns. Selected types of sustainable building implementations. (Bourdeau et al. 1998). To sum up, in (Table 2) some selected definitions about sustainable construction and buildings are shown.

3. ENERGY CONSUMPTION DURING THE LIFE CYCLE OF BUILDING CONSTRUCTION

Building energy consumption can be expressed by two perspectives: single building energy consumption as well as macro-level creating energy usage. There tend to be various buildings(constructed with regard to residential, workplace and industrial, public structures, etc.). in one country, and they consume energy in different ways. It is impossible to analyze energy consumption of every building; but we can get results in average level. About this basis, energy use of buildings within the whole nation (macro-level) could be estimated..

Figure 3: Phases of Life-Cycle energy analysis

The lifespan cycle from the building consists of the manufacture of creating materials transportation from the building materials towards the construction website erection of creating occupancy restoration demolition as well as removal stages Energy consumption through the life amount of the creating Elife cycle kWh may be the sum of the various energy consumption during the different phases and calculated as below.

$$\mathbf{E_{Tlife\ cycle}}=E_{manufacture}+E_{transportation,\ production}+E_{erection}+E_{occupation}+E_{renovation}+E_{transportation,\ renovation}+E_{demolition}+E_{transportation,\ removal}$$

3.2 Energy consumption in production phase

Energy is needed for production and building material. The actual manufacturing power requirements associated with some building materials tend to be presented in Table 1. The waste of every material produced throughout the erection from the building can also be shown within the same desk. The waste materials are expressed as a waste element wi. The power requirement with regard to manufacturing and also the building materials, E produce (kWh) could be calculated the following (Adalberth, 1997):

$$E_{\text{manufacture}} = \sum_{i=1}^{n} m_i(1 \pm w_i/100)M_i$$

where n = quantity of materials, *i* = the material of concern, m_i = sum of the building material *i* (ton), w_i = the factor for waste of the building material *i* reduced in erection (%), and M_i = energy required for manufacturing the building material *i* (kWh/ton).

Table 3: Energy consumption for building materials

Materials	**Mi (kWh/ton)***	**wi (%)****
Strengthened	560	20
Concrete	210	10
Basic Concrete	2000	10
Tiles & clinkers	7230	0
Glass	24650	5
PVC	29650	10
Polystyrene	7000	5
Paintings: Paints & lacquers Metal	8890	5
Electric wires, copper	19780	5
White goods, 1110 kWh/per item	-	-

* Source: Andersen et al., 1993** Source: Larsson, 1983

Energy is required for shifting construction materials in one place to a different. The transport happens from the manufacturer to the actual building site, when the actual building has been erected or even renovated. The transport of uncooked and semi-manufactured supplies is contained in the manufacturing power. Various power uses related to different types of transportation is actually shown in Table 4.

Table 4: Energy consumption for transportation of building supplies

Transportation	**T_c(kWh/ton km)***
Long Distance Road (distances > 50 km)	0.28
Long Distance Road (distances ≤50 km) 0.75	0.75

* Tillman et al., 1991

The power used with regard to transporting the actual building supplies E transport, erection (kWh) in order to and in the building location in erection could be calculated (Adalberth 1997)

$$E_{\text{transportation, erection}} = \sum_{i=1}^{n} mi(1 \pm w_i/100)d_i T_c$$

Where n = quantity of materials; i = the material concerned; m_i = quantity of the building material i (ton); w_i = factor for the waste of the material i produced during erection of the building (%); d_i = distance from the constructor of the material i to the building site (km) and T_c = energy necessary for the conveyance concerned (kWh/ton km).

Energy is needed for many erection stages of a building such as for instance drying and drainage, the heating of sheds and of the building itself, electricity for lighting purposes and for machinery, and so on. The energy pertaining to the various processes is given in (Table 5).

Table 5: Energy consumption for transportation of building supplies

Materials	**P_i ***
Drying of standard concrete on building site	44 kWh/ton
Drying of concrete element	25 kWh/ton
Smoothing of soil	32 kWh/m^3
Excavation and removal of soil	3 kWh/ton
Long Distance Road (distances ≤50 km) 0.75	26 kWh/m^2 usable floor area

* Source: Andersen et al., 1993

The energy use for different processes in the erection of a building $E_{erection}$(kWh) is estimated as follows (Adalberth, 1997):

$$E_{\text{erection}} = \sum_{k=1}^{n} p_i P_k$$

where m = quantity of processes; j = the type of process; p_i = the quantity of the process j (ton, m^3 or m^2 usable floor area); and P_j = energy necessary for the process j (kWh/ton, kWh/m^3 or kWh/m^2 usable floor area).

3.2 Energy consumption in the renovation of a building

When the energy use throughout the renovation of the building is actually calculated, some assumptions concerning the lifespan from the various building materials need to be made. Lifetime associated with some materials receive in (Table 6).

Table 6: The life spans of construction materials

Lifetime of building	**Life span (annual)***
Lifetime of building	**50**
Frame (External walls, internal walls, insulation)	**50**
Parquet flooring	50
Water plumbing and electrical wires	50
Ventilating stations	50
Facing: wooden paneling	30
Doors and windows	30
Wardrobes & cupboards	**30**
Roof covering tiles as well as drain plumbing	30
Plastic carpets	**17**
Water heating unit	16

White goods	12
Painting & wallpaper.	10

* Source: SABO

The energy consumption for producing the building materials during the renovation, E $_{renovation}$(kWh), is estimated as follows (Adalberth, 1997):

$$E \text{ renovation} = \sum_{i=1}^{n} \text{mi}\left(1 + \frac{\text{wi}}{100}\right) \text{Mi}\left\{\cdot \frac{\text{lifetime of abuilding}}{\text{lifetime material i}} - 1\right\}$$

The energy use, E $_{transportation,\ renovation}$(kWh), for transporting the building in renovation is estimated as follows (Adalberth, 1997):

$$E\text{transportation , renovation} = \sum_{i=1}^{n} \text{mi}\left(1 + \frac{\text{wi}}{100}\right) \text{Mi}\left\{\cdot \frac{\text{lifetime of abuilding}}{\text{lifetime material i}} - 1\right\} (\text{di} + 20)\text{Tc}$$

3.3 Energy consumption in the demolition phase

Demolition phase consists of demolishing as well as removing debris in the building website. The power use with regard to demolishing the actual building At the demolition, (kWh), is estimated the following (Adalberth, 1997):

$$E \text{ demolition} = \sum_{k=1}^{m} \text{pk Pk}$$

Where m = number of processes; j = the type of process; p_i = the amount of the process j (ton, m_3 or m_2 usable floor area); and P_j = energy required for the process j (kWh/ton, kWh/m_3 or kWh/m_2 usable floor area).

The energy use, E $_{transportation,\ demolition}$ (kWh), for transporting the building in renovation is calculated as follows:

$$E\text{transportation, demolition} = \sum_{i=1}^{n} \text{mi}(1 + \text{w}_i/100)20\,\text{T}_c$$

20= the assumed distance from the building site to the waste disposal site (km); and T, = energy required for the conveyance concerned (kWh/ton km).

4. CONCLUSIONS

Sustainable construction is really a new concept that needs considering the actual sustainability objectives for those decision making throughout the life cycle from the built service. The idea of sustainable improvement has various priorities in various economies, but illustrations of its implementation could be listed the world over. The idea of lean construction has already been offering the actual conceptual foundation and possibility of novel techniques and resources for environmentally friendly construction. Joint initiatives are known as to encourage further development to enhance our standard of living through durability. It is important for creating construction to reduce energy usage for sustainable development. Energy preserving with regard to large-scale open public structures may be the a key point of creating power preserving. On another hand, improving the building

quality and lengthen the lifespan of the building will also reduce the energy consumption and carbon dioxide emissions. The choice of energy resource is also important. Egypt must improve power efficiency as well as optimize the power construction. If lean energy, including nuclear power, hydropower, and wind power account for a higher share of the total energy, carbon emissions will be reduced notably

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